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A Monthly Popular Journal of Knowledge

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Locusts of Timbuctoo

By O. Bevan Lean

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DISCOVERY

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Notes of the Month

Of all the multifarious activities that His Majesty King George VI has taken part in during this last month of great occasions, none has been of more significance in the sphere of knowledge than the opening of the National Maritime Museum at Greenwich. That a nation which for centuries has looked upon the sea as its especial province should have no public and official record of its maritime history has often been the subject of adverse comment; but all criticism is now answered, for the Trustees have regarded the scope of the Museum in its widest aspect, and have included within its walls all that applies to the life of seamen, whether of the Royal Navy, the Merchant Navy, or the Fishing Fleet. The result, at long last, is as complete a collection of exhibits, illustrations, and documents as may be wished. The Trustees and especially the Director, Professor Geoffrey Callender (whose work at Greenwich is already well known), deserve the enthusiastic thanks of their compatriots.

* * * *

The National Maritime Museum enjoys the signal privilege of being housed in a building that is in itself a "museum piece." The Queen's House was designed by Inigo Jones in 1618 for Queen Anne of Denmark and finished in 1635 for Queen Henrietta Maria, and is an admirable example of English Palladian architecture. Its colonnades (commemorating Trafalgar) and flanking wings were added in and after 1807. But while the beautiful proportions of the 17th century rooms undoubtedly add to the attraction of the Museum, the necessity for respecting an ancient monument made the problem of arrangement all the more difficult. Visitors will find that the problem has been adequately solved. In the original Queen's House, maritime history down to 1702 is illustrated; later exhibits are in the wings. This is not the place to catalogue the collections of the Museum, but reference should be made to the Caird Galleries, specially equipped at the expense of Sir James Caird to accommodate the Museum's unsurpassed collection of naval pictures. The high quality attained by many of the paintings may be gauged by our illustration on the following page.

* * * *

The publication by the Air Ministry of *A Meteorological Chronology to A.D.* 1450 (H. M. Stationery Office, 8s., postage extra) is most welcome, both for its own sake and as a sign of a new breadth of vision on the part of the Ministry concerned. Generally speaking, the publications of the Air Ministry so far have been severely technical; but here is a volume that should be of highest interest to all students of the weather. Like every advance in knowledge, the publication of this *Chronology* has met with hostile criticism, and the Under-Secretary for Air was obliged to justify his Ministry's action to the House of Commons. Mr. C. E. Britton, author of the *Chronology*, should be well satisfied; captious objections only go to prove that he is a pioneer. To airmen the value of his work, which provides a historical background for the study of current weather conditions, must be obvious; and if some of the records he deals with are untrustworthy, he is the first to call attention to that fact.

* * * *

A recent number of *Radio-Helios* reports the construction, in Germany, of the first wireless set with scales printed in Braille, with the result that a blind person can now easily make a selection among 22 sending stations. The markings for 12 German and 10 foreign sending stations in Braille are arranged on a slanting surface below the actual scale, in the form of small raised

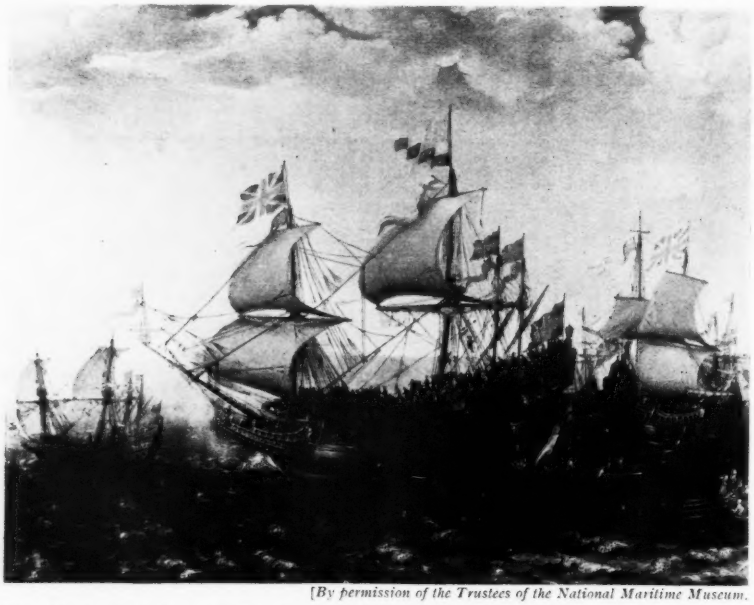
points, such as are used in the Braille printing system. As there is not sufficient room to give the full names of the different sending stations, only the first letters of the German stations are given, whilst the foreign stations are distinguished by the initial letters of the countries in which they are located. The blind operator feels the initial letters along with the scale pointer, for which action it is provided with a special tongue protruding through a slot which is left open in the covering glass plate for the purpose. Broadcasting means infinitely more to the blind than to those able to share normally in the activities of their fellows, and the new apparatus, which is moderately priced, is a real advance towards their full enjoyment of the advantages of the wireless.

* * * *

Professor E. N. da C. Andrade delivered the twenty-seventh Annual May Lecture before the Institute of Metals last month in the Hall of the Institution of Mechanical Engineers, London. His subject was "The Flow of Metals." Flow is most easily observed, he said, in the liquid state, but whereas there is a satisfactory theory of gases, and the structure of crystalline solids has been elucidated by the methods of X-ray analysis, very little is known of the actual behaviour of the molecules in the liquid state. It lacks the regularity of the crystal, and the molecules are too close to show the simplicity of behaviour that characterises gases. Professor Andrade has put forward a theory of liquid viscosity on the basis that the momentum is transmitted from layer to layer not, as in a gas, by the passage of molecules from one layer into the other, but by instantaneous association of the molecules when they touch, so that at any nearest approach two molecules share their momentum. On this basis a formula can be derived which gives the viscosity of a simple liquid at its melting point, and another which gives the temperature variation of the viscosity.

* * * *

The flow of solids is, perhaps, at first sight, even more troublesome theoretically than the flow of liquids, for single crystals of metals exhibit plastic flow under very small stresses, whereas a perfect crystal should firstly be strong, and secondly be brittle. Again, single crystals of metals show a very marked hardening with flow. To explain how it is that metal crystals can flow at all, various workers have suggested, with different detail, that, in the ordinary crystal, places exist where the atoms are out of step, for a small distance, with their immediate neighbours, such regions being called "dislocations" by Taylor. It can be shown that quite a small shear stress will cause such a dislocation to run along, leaving the atoms in the region through which it passes advanced by one. The weakness and the flow of single crystals is explained along these lines. It is, of course, a far step from the single metal crystal to the polycrystalline metal of industry, but we can see that any crystal boundary is likely to stop the propagation of a dislocation, or glide in general, and so will make the metal less weak and less liable to flow.



[*By permission of the Trustees of the National Maritime Museum.*

The Elector Palatine leaving England (1613), *by Adam Willarts, a fine example of the naval paintings on view at the National Maritime Museum, Greenwich; reprinted by courtesy of the Museums Journal.*

* * * *

The Ordnance Survey's recent new (5th) edition of the map of *London* in the one-inch series comes opportunely at the beginning of the season for walks abroad. It covers a very much larger area than the name implies, extending, as it does, from High Wycombe to Caterham, and from Farnborough to Chigwell Row. Although one of the most noticeable new features in the region dealt with is the extension of built-up areas, plenty of open country still survives, especially in the western half of the map, and the various routes for getting out of London are clearly shown. The map is sold in four styles, from 1*s.* 6*d.* (paper flat) to 4*s.*

LOCUSTS OF TIMBUCTOO

By O. Bevan Lean.

In the course of a six-months' investigation of the breeding habits of the grasshopper in the Middle Niger the author discovered a number of important facts bearing upon the occurrence of locust swarms.

In May, 1932, at the little mud Bozo and Peuhl village at Diafarabe in the French Soudan the price of locusts was 50 centimes a head, dead or alive, so long as the specimens were in good condition. Only at this price was I able to collect sufficient insects to assist my study of the particular species of locusts in its natural breeding ground. The story leading up to these investigations goes back a few years. In 1930 swarms of the migratory locust began to enter Nigeria, and reports told how all the other British and French Colonies in West Africa had been invaded. Towards the end of the year some of the locusts moved east, past Lake Chad, over French Ubangi Shari to Khartoum, and while all the area from Cape Verde to the Red Sea was still infested, daughter swarms turned south and gradually invaded the Belgian Congo, Kenya, Nyasaland and the Rhodesias, while one or two penetrated as far as the Cape. It was not known from where the locusts had come; for 25 years West Africa had been free of the pest, and then suddenly colony after colony was invaded.

Meanwhile, all records of swarms were being collected by the British Museum, and in 1931 I was able to prepare a series of maps charting the positions of the locusts month by month. These maps told a tale. Going back through the series, the swarms converged on the French Soudan, until in August 1928 two were seen in what is known as the area of the Middle Niger near Timbuctoo, and the first report had come from Diafarabe. In 1932 I had the opportunity of following the locust back to his home, hoping that a study of his habits there, the environment in which he lived, and all the factors that might affect his well-being, might tell us why this particular insect had multiplied so spectacularly in that one area at that particular time. Forewarned is forearmed, and next time Africa might be prepared to fight before the locust flew abroad.

A brief outline of the biology of the locust is necessary. It must be understood that there are a number of species of locusts found in different countries in the tropical and sub-tropical areas of the world. Scientifically my locust is called *Locusta migratoria migratorioides* R. & H., and he is one of the more important species indigenous to Africa. A locust looks like a large grasshopper and, in fact, is a grasshopper that has temporarily put aside his hopping habits. From a solitary insect that prefers hopping to flying, he has become a gregarious individual with a migratory instinct. *Locusta*, therefore, has two phases, the *solitaria* when he lives like a grasshopper and the *gregaria* when he behaves as a locust. Since Africa was last over-run, until 1928, *Locusta* had been existing in phase *solitaria* as a well-known insect in most of the grassland areas of the Continent. It was presumed that some phenomenon had broken the normal cycle, causing the appearance of true locust swarms in 1928, and for six months I wandered through the swamps of the Middle Niger area trying to solve the mystery of why this transformation occurred.

Now if a number of *solitaria* of this or any other locust species be bred in a small cage, their progeny will develop into locusts, while if a few locusts be bred in a large cage their children will be grasshoppers. In some way the phase can be determined by the population per unit area. The life cycle of the locust should also be outlined. The female oviposits in the ground, laying some 70 eggs in a hole, excavated by the hardened tip of the abdomen, about two inches below the surface. After two weeks, minute white insects force their way to the light and immediately change their skins and become small black hoppers about one-fifth of an inch long. These hoppers grow and moult five times over a period of perhaps six weeks before attaining the winged adult stage. The life histories of phases *solitaria* and *gregaria* are similar, but the *solitaria* hoppers scorn their brothers' company and disperse amongst the vegetation, while all the *gregaria* hoppers stay together in what are known as primary bands. The hoppers from one egg mass join

forces with those from others, and in mass formation wander over the ground. If they meet more hoppers, they form larger bands, and gradually vast armies, perhaps a mile long, may foregather. When they get their wings they still remain together but, instead of hopping a mile a day, they fly around the country in dense swarms. There are normally two generations of the *gregaria* a year, but while the number of generations of *solitaria* is not known definitely, there are probably at least three, and perhaps four.

The *solitaria* hoppers and adults are typically green and occasionally black, while the *gregaria* hoppers are black with orange markings and the adults are brown. The *solitaria* adults of both sexes retain their original colour, but the male *gregaria* becomes yellow when sexually mature. There is one other important difference between the phases. The *solitaria* dislikes flying and is more developed in leg than wing, while the *gregaria* is obviously a strong flier. Because of this, and fortunately for our studies, the phase of an individual can be determined by measurement. If the first main joint of the back leg is more than half the length of the outer wing, the specimen is a *solitaria*; if less, it is a *gregaria*. The *solitaria* therefore differs from the *gregaria* not only in habits, but in bodily form.

On the greater African rivers the usual transport for Government officials and traders is a most unpretentious metal flat-bottomed barge with a single square cabin situated amidships, about as comfortable and beautiful as a cattle truck. Throughout my tour one of these served as my headquarters and, in spite of all the discomforts of blazing suns and tornadoes—she leaked like a sieve—I came to regard her as a home. The cabin measured twelve feet by five, and this was my office, laboratory, dining-room, bedroom and bathroom. On the flat roof was piled my baggage, a tent, and probably two servant boys amongst the firewood; in the bows stood the six polers thrusting the barge forward at a fast walking pace, hour after hour from dawn to sunset. In the stern, Max, my cook, Amudu, the crew's cook, both probably asleep amongst their pots, the Moma the headman at the rudder. We were a cheerful ship's company, except when Max stole Amudu's last lump of dried fish and was pushed into the river among the crocodiles. Behind the barge followed the baggage canoe, with two technical assistants and two polers. We embarked at Segou in April, and until October the locust investigations took us a thousand miles along the main river bed, up tributaries and backwaters, across such lakes as Debo, which even at low water covers 325 square miles and which, as we discovered, could be lashed into a violent rage by even a small tornado. Downstream all the way to Timbuctoo we travelled fast, and when the wind was favourable the polers were able to rest all day long as we made a merry pace with my large groundsheet hoisted as a sail. Returning upstream, against the rising river, progress was frequently painfully slow, and often the current was so swift that the crew were forced to abandon their poles and tow the barge. Before the real rains started we camped at dusk on sandbanks, but for the last three months the whole plain for hundreds of miles was under a few feet of water, and the only dry land was the occasional rise on which the little native villages and cemeteries were perched.

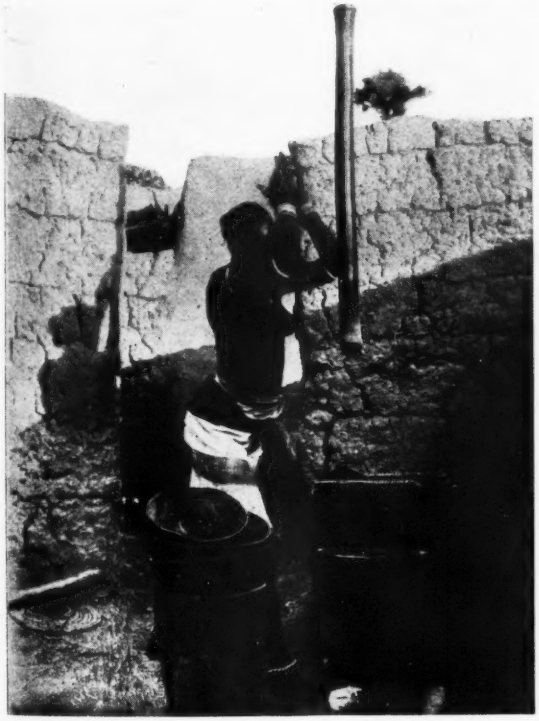
The author's barge, in which he lived and worked.

Throughout the journey we made frequent halts to study the insect population, and if solitary locusts were found, then large numbers had to be collected, and their legs and wings measured to a tenth of a millimetre to determine their phase. If, as at Diafarabe, these grasshoppers were common, their distribution and habits were studied in great detail, and actually I spent three weeks at Diafarabe on the outward journey and another week on the way home.

As a result of this survey several valuable discoveries were made. The *solitaria* were found over the whole Middle Niger plain from Ke-Macina, a few miles east of Segou, to Kabara the port of Timbuctoo. If we went away from the plain into the surrounding country, where the grassland changes into open forest, no *solitaria* were found, and even on the plain they were never present in any wooded area, only in the open grassland. And not only this: within the grassland they were most numerous in one particular association dominated by a coarse tufted grass called by the natives *dhub*, which, because of its evergreen habits, escapes the bush fires that are so destructive during the dry season. The

association between *dhub* and *solitaria* was so marked that I was soon confident that if the belts of the grass were mapped by an aerial survey, I could readily point out the most likely localities where locust swarms might be born.

It is obvious, therefore, that our survey had to cover the vegetation and, through the vegetation, the soil factors as well as the relationships between plant associations and river levels. During the dry season the distribution of the vegetation was as clear as any coloured contour map. The different types of grasses occurred in definite zones, always in the same order as one moved away from the river bed, and it was fairly evident that



A girl of Diafarabe pounding corn. At regular intervals the pestle is thrown into the air, while she claps her hands.

these zones were related to the land contours. Throughout the Middle Niger plain the whole country, except for occasional outcrops, varies only a few feet in height, but if the ground rises or falls a matter of one foot the grasses change. The specially interesting *dhub* grass always occurred at a high level, and if the slope of the land was very gradual the *dhub* might extend for a few miles, while if the land sloped rapidly down to the river the strip of *dhub* was perhaps only five yards wide. The rise and fall of the river had also to be considered. Anyone knowing the Niger Valley only in the wet season

Dhub grass, the home of the solitary locust, at Diafarabe

would recognise few landmarks at low water. At one season the river meanders through the three-quarter-mile-wide main channel and at the other the 12 ft. clay cliffs are overflowed as the flood rushes out over the whole plain. But the time and extent of the flood vary annually, and this is probably important from the locust point of view, for in a high flood no ground remains unsubmerged, while with a low flood the higher levels, where we found the *dhub*, remain.

On the shore of one of the lesser lakes we watched the rising river driving hoppers towards the high ground, and it is not difficult to picture them being forced on to small islands where the population will become so dense as to induce the formation of phase *gregaria*. During my first visit to Diafarabe I examined 346 locust specimens. Not all of these cost 50 centimes each, for my own party collected large numbers, and also in the middle of my stay the bottom fell out of the locust market. One afternoon I was taking meteorological records when I noticed a familiar haze on the horizon, and it was not many minutes before it was obvious that a locust swarm was heading straight for the village. I had to act quickly, and messengers were sent through the streets and markets proclaiming that no more locusts could be bought. Heedless of this notice, dozens of boys and girls, men and women, came along with calabashes, bags and kerosene tins full of locusts, each person claiming what to him would have been a small fortune.

(*Continued on page* 175)

Climbing Kilimanjaro

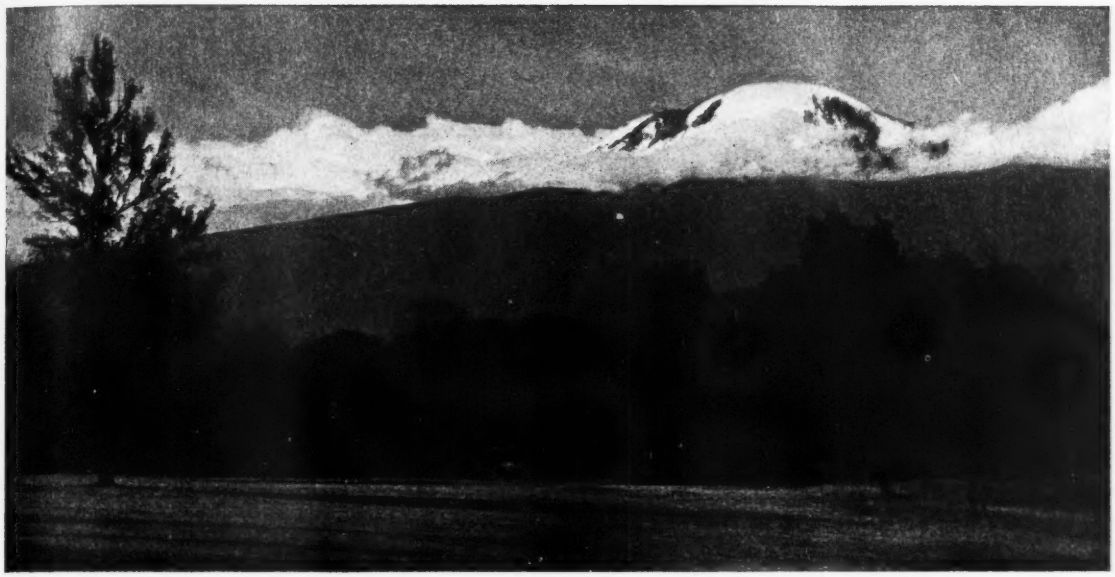
The diary of an English girl's journey up and down Africa's highest mountain.

" At mid-day we went up to Dr. Reusch's, and at 12.45, after he had superintended the loading of the porters, we started. It was very hot walking up through the native shambas, on a dirty path that smelt. After half an hour we stopped and lunched; then continued stiffly up through a sort of moorland. At 2.15 we gained the welcome shade of the forest: there we collapsed and wiped the sweaty brow. Then on and up through the forest, English beech woods, only darker, with festoons of creeper from all the trees, and heavy-leaved orchids. At 3.15 we stopped again, but a porter said 'Water ahead,' so we hurried on till we met a heavenly stream. We lay and washed our faces, much begrimed, and drank our fill. Then some boys came down with freshly filched honey in a filthy bag. Our porters fairly whooped with joy, and promptly got all sticky with it, after which they handled our things again, and they got sticky, too. A dirty paw was held out to me with honey in it, and I cautiously broke a bit off and chewed. It was very pleasant, but terribly sweet. . . .

Natives of the Kilimanjaro district. Note the bullets worn as ornaments by the man in the centre.

" On through the most weird country, like another world, very still, with naked trees draped with fungus and old man's beard, so that they looked like Sleeping Beauty's palace at the end of the hundred years, all musty and cobwebby. Our legs ached and we were told 'two and a half more hours to go.' We left the porters behind and emerged into grass-land, which was like walking through a hay field. At 5 we were there, much to our joy and amazement. What a view! Lake Chala, deep, deep blue; Jype, a dirty oblong; Taveta, a misty green; the Pare hills like a humped plush tablecloth; and the plains. . . . We bellowed for tea even before we opened the hut. It was a three-roomed affair smelling somewhat. That tea was good, and we had a good dinner: chicken, bacon and spaghetti fried, potatoes in the oven, and more tea. We made the sandwiches for to-morrow; we wanted to leave at 6. The fire gave a pleasant warmth; for baths we sat in front of it with a *debbi* each of hot water, and soaped and gurgled to our hearts content. We were 8,400 ft. up, at Bismarck hut, with twelve miles done.

" In the morning the alarm went at the right time. I leapt out, shouted for a fire, and leapt back—brrr! By six we had had tea and a banana, and watched the plains materialise out of mere rose-coloured mist. At 6.25 we left, and the sun was up. We climbed a steep hill up through the forest, dank and weird, and saw great uprootings where elephant had been through in the night. Half an hour later the forest suddenly stopped and Kibo and Mwenzi (the twin peaks of the mountain) rose out of nothingness beyond range after range of grass covered hills. It was a wonderful sight. The rest of the day was walking over those hills, up one and down the next—mostly up! Rather like English downs only the grass grows in thick tufts and is knee high; sundry lovely flowers, anemones, harebells, gradually turning as we got higher to 'everlastings,' mostly yellow or white. At 8.30 we stopped for breakfast. The egg and chicken sandwiches had somehow got mixed up with the paraffin, which was odd, as the latter was quite half a mile behind. Dew was still on the grass, and it was cold sitting. We pushed on again at 9.15, up steep slopes, with odd bits of flat. At 10.10 we stopped at an icy stream and drank happily. Grass gave place to rough boulders, hard on the ankles, and heathery stuff—giant heather perhaps, but I couldn't find a single flower so I couldn't be sure. Sometimes we saw the two peaks, more often only one showed above us, the other being hidden by more and yet more hills. Mwenzi is the more awe-inspiring of the two, horribly jagged and unfriendly. At 11.30 we reached the next hut. These huts have a habit of suddenly appearing, just at the right moment, most



The peak of Kilimanjaro.

considerate of them. A tin shack stuck slap out in the open with a stream below, and the most perfect view in the world. The porters had stopped to cook at the last stream, much to our annoyance, so we had to hang about before we could get any tea. It was a much pleasanter hut inside than Bismarck, with one room, four bunks, and a sort of a stove. The walls are covered with people's names, drawings, remarks, etc., such as Perkins, Dawes, ' Not a Londoner's idea of a holiday. Reached 14,000, feet good, but me 'eart wouldn't let me ' ; S.A.R. ' Couldn't go any further on account of heart failure, and no bloomin' chocolate left ' ; ' I micht hae got tae th' tap, but I hadnae th' time ' ; Flora Day (the novelist, Julie Peters), and the five American students who caused the mountain club and the government some anxiety and much displeasure by refusing to take porters or a guide. We didn't eat ; we fell down and slept. Gee ! it was cold, the wind whistled in through all the chinks. I woke at three, and there in the middle of the floor three little rats were playing, having a grand time. Got up and wandered out to get some flowers, chewing bread and potted meat. We just had coffee, not too bad and very hot. We've learnt the lesson that bubbling water at this height is not hot. We took olive oil. It made me feel far sicker than any mountain could. People have been very mountain-sick at this hut, but we both felt fine. So that was Peter's Hut, 11,500 ft. ; 11 miles to-day, 10 to go to Kibo Hut.

" We set the alarm for 5.15 the next morning, but it never went off, so we left three-quarters of an hour later than we meant to. We got out of bed and it was like getting up in mid-winter at home ; our clothes were well-nigh frozen. An amazing world was below us, with layer upon layer of clouds ; the Teita hills and the Pares showing as islands in the hummocky sea. Kibo behind us was tinged with pink and even Mwenzi looked a little less fierce. We left at 7.10, and climbed up and over one blank hill after another with sparser vegetation ; any damp patches were frozen over. At 9.30 we came to the last hill and looked on a strange land. Mwenzi on the right, Kibo in front of us, and away on its side we were shewn a tiny white patch. That, we were told, was the hut we were making for. It looked twenty miles away at least, and in front of us lay rock and grit, loose stones and lava dust, a desert, and then the slope running up to the hut. It looked like yellow grass-land, but proved to be dust and ashes. The whole effect was rather like pictures one sees of the moon, or Mars.

" A little before this we had seen a native tearing down hill towards Peter's Hut. He told us that he hadn't had any food for three days ; he didn't know where the memsahib was that he had brought up, or when she was returning, and anyhow she couldn't speak English or Kiswahili. All very vague, in fact. We met the good lady herself. A hefty German with an ancient helmet worn back to front, brandishing an ice axe, and clad solely in breeches and a shirt. She was blue to the lips, which had great sores on them ; her hands and face were bare, she hadn't even got any glasses. We couldn't talk to each other for she didn't know a word

of English and we didn't know any German, still we gathered that she had got to the top, and had slept in the caves. That she hadn't got any keys to the huts and so she was sleeping just anywhere. She was carrying her own kit too! She was thrilled when we gave her a few raisins. We sat and grinned inanely at each other for a bit, and then we pushed on.

"At 11.30 the hut looked as far away as ever, my legs practically refused to function. We were going about a mile an hour. We got to the Caves about 12: 500 yards away was the hut. The clouds had come up round us. Mwenzi had gone and only one white shoulder of Kibo was visible. It took us thirty-five minutes to do that last bit, stopping every hundred steps. We met four of our porters going down again and discovered that they were going to wait for us at Peter's. We seem to have precious little wood. We fell into bed. I had tea with lemon and brandy, a biscuit, and we slept. A hail storm woke me up, and then it began snowing. We had to go slow with the firewood, which was a bore. We lay in bed most of the time. This was much the nicest hut. Small, warm and fuggy. There was a book with various people's achievements—written in all languages. The American students were all sick and headachey here, but they all went on. That was Kibo Hut. About 15,500 ft.; 10 miles done, about six to go.

The Final Struggle

"We set the alarm for 3.15 a.m., and left for the top at 4. When I got up to shout for the boy the moon was slap over the top of Kibo, which rose straight above the hut. By 4 it had vanished over the top and we had to start with a lantern. It was very cold. We started with all available clothes on, and still we were cold. At 18,000 ft. and 6.15 a.m. we watched the sun rise over Mwenzi, but the two hours before that had been a complete nightmare. Struggling up over boulders, and through ash and gravel in the dark, I thought I'll never do it. It was better when the sun was up. Then the slope went up like the roof of a house. Up one step, slip two. We breakfasted off brandy and raisins at 9.15. It got worse and worse. I was all in. As soon as I sat down to rest I was dreaming, and asleep. It was only with a terrific effort I kept awake at all, and it got steeper and steeper. At 11.15 we were about 100 yards from the top. At 11.45 we staggered over the final rock (myself ignominiously clutching the guide) and there in front of us was a solid wall of ice. A magic land, Leopard Point, 19,500 ft. It was amazing; 150 to 200 ft. high, half a mile wide, and beyond to the right another wall, this one all blue jaggedness. Gillman's Point was about 26 ft. higher over rocks. We got up there, a narrow pinnacle of rock, with a small cave where the 'Visitors' Book' is kept, also a Bible and a Prayer Book. From here you can see the whole crater, smooth stretches of snow, deep blue lakes of ice, sharp pillars of intense whiteness; a wonderful, awe-inspiring, somewhat terrifying sight.

A Rapid Descent

"On our right as we sat up there was another wall of snow, the dome that one sees from the plains. At 12.15 we thought we'd better go, so we came down and were back at Kibo Hut at 1.40! In other words we sat and slid; a heavenly sensation, except when your boots got overfilled with debris. We both had blisters when we got in, but it was worth it. Seven and a half hours to go up; one hour and twenty-five minutes to come down. I fell into bed with a couple of aspirins and slept hard till three. We'd decided to go back to Peter's Hut that night. We washed our feet, took off half our clothes and set out at 3.30 across that foul desert. In the middle of it a hail storm hit us good and hearty, and we really hurried. Up hill and down dale, we left Kibo and Mwenzi standing in their desert land. We reached the hut at 6.15. There was a German girl here, too, and she had the fire end of the hut. She told us more about the German woman; how she had been in Africa for four months touring on a bicycle with very little money. She asked Dr. Reusch to help her make arrangements to climb the mountain but as she had no money to pay for the huts or porters he refused as he said it was madness. So she found one boy and went off, sleeping in the lavatories of the two lower huts. The third has none, so she went higher and slept in a cave (18,000 ft.!). The only extra garment she had was a nightgown, which she put on over her clothes.

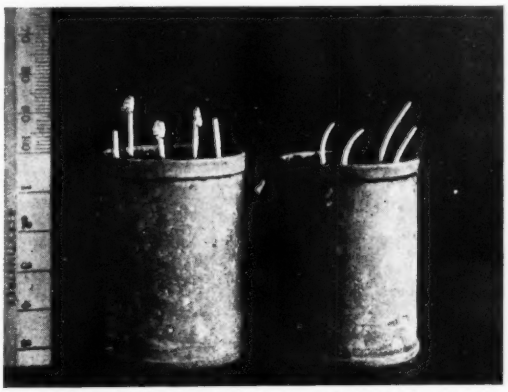
"We left Peter's at 7, and at 10 a.m. we were down at Bismarck, only having stopped for me to get flowers; eleven miles of the last stretch done. The last bit, through the forest, was lovelier than I remembered it going up, perhaps because it was downhill. There was a bank of violets just as we got into the forest, which was cool and refreshing after walking over meadowland where every step is a snag. We stayed at Bismarck till twelve, had some food and made ourselves more or less presentable. Then we had twelve miles more to do, eight through delightful forest with a stream running alongside the path most of the way. This water was a surprise; the watercourse had been dry when we went up. Then we had four miles of native *shambas*, burning hot under-foot, dust flying up in our faces, but we had made up our minds to do it by three, so fairly raced along, and got to the Mission exactly at three. We had taken just four days and three hours."

Plant Hormones

By Eric Ashby.

The immense importance of hormones to animals and man has overshadowed the part played by hormones in the life of plants: yet the hormones of plants are no less remarkable and decidedly easier to experiment on.

You may carry out experiments on plant hormones at your sitting-room window. Get a handful of oat seedlings and sow them in a pot of soil, filled to the top. Cover the pot with a plate of glass and keep it in complete darkness. The first white pointed sheath to appear is not a leaf, but the coleoptile, a hollow cylinder which encloses the first leaf and the growing point. When the coleoptiles are about half an inch high transfer the pot of seedlings to a blackened box, with a hole about the size of a penny at one end. After a couple of hours you will find all the coleoptiles turned toward the light. You will notice that it is not the tip which has bent, but a region just below the tip.



The coleoptile of oats bends toward the light unless the tip is cut off or covered with a cap.

An experiment may now be performed with three lots of seedlings, grown in the dark. Cover the tips of some with caps of tinfoil or the paper chocolates are wrapped in. With a sharp razor cut off the top millimetre (no more) of some others. Leave the third lot untreated, and put them all in the dark box with a hole at the end. After two hours you will notice that the two lots of treated seedlings have not responded to light: the beheaded coleoptiles will scarcely have grown, the covered coleoptiles will have grown vertically. The untreated seedlings will have turned toward the light as before.

Growth and bending does not take place at the tip, but below it. Yet, if the tip is covered with tinfoil or cut off the seedlings do not respond to the direction of light. The tip of the coleoptile must "perceive" the light, and the region below "responds" to it. Also, since scarcely any growth occurs in a beheaded coleoptile the non-growing tip must have some control over the growing region below it.

You may now carry the enquiry further. Germinate some oat seedlings in darkness, as before. Cut off the tips of some of them, and measure the height of the stumps. Leave the seedlings in darkness for four hours. At the end of this period the beheaded coleoptiles will not have grown. Now remove a few coleoptile tips from other seedlings, and with a fine pair of forceps put them on the stumps of the beheaded coleoptiles. Then expose them to unilateral light. They will turn toward the light as well as normal seedlings, and will show an obvious increase in length. You can repeat the experiment, covering the coleoptile stumps with the juice of coleoptile tips instead of the tips themselves. So long as the atmosphere is very moist and the juice does not dry up, you will get the same result—the juice is enough to cause growth, though in this case the stumps will not bend toward the light. This is about as far as you can take experiments without the facilities of a laboratory. They teach that the tip perceives the direction of the light, and transmits the stimulus somehow to the tissue beneath, which responds by growing toward the light. Furthermore the stimulus will pass across a cut surface—the tip and the stump need not belong to one another—and the juice of a tip is as effective as the tip itself in providing a stimulus to growth.

Experiments like these suggested to botanists that some hormone-like substance might be produced in the tip, and might stimulate growth by diffusing into the tissue below. They found that not only did the stimulus travel across a cut surface, but it also travelled through a slice of agar jelly put between the tip and the stump. This gave a Dutch botanist, F. W. Went, a further idea. If there is a hormone, why not collect it in agar jelly, and use cubes of jelly instead of coleoptile tips to stimulate growth? Accordingly he carried out the following experiment. He cut off a number of tips and stood them on a plate of agar jelly, in the hope that the hormone would diffuse into the jelly. Then he cut the agar plate into smaller plates measuring 2 by 2 by 0.5 millimetres, and placed one of these on a decapitated coleoptile of oats. The coleoptile immediately grew in length. Then a block was placed asymmetrically on a stump. The side on which the block rested grew; the other side did not. Consequently the stump curved.

Clearly something had diffused out of the agar block

into the stump, and stimulated it to grow. The results were more remarkable than this, for it was found that the potency of the agar block depended upon the number of coleoptile tips which had diffused into it. If twice as many tips were put on the agar plate, blocks from the plate caused twice as much bending in a beheaded coleoptile. Went found that in this way he could measure the amount of substance which diffused out of the coleoptile tip into agar, from the amount of bending produced by a standard block. He defined one " Oat Unit " (Avena-Einheit, or A.E.) as the amount of hormone present in a block 2 by 2 by 0.5 millimetres which causes a curvature of 10° in the stump of a coleoptile of oats.

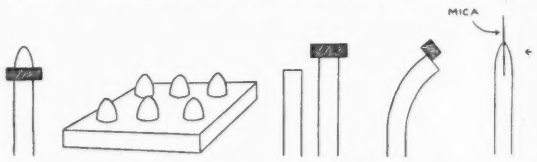
The growth-promoting substance was named auxin. Two main problems had now to be solved: firstly, what was auxin; could it be collected and purified or synthesised by chemists? secondly, how do factors like lateral illumination affect the production of auxin, to cause the familiar bending toward the source of light?

The isolation of pure auxin from coleoptile tips was an extremely difficult and laborious business. Eventually a few crystals of pure auxin were obtained, with a potency in " Oat Units " of 50,000 million units per gram. There was no doubt that the plant growth hormone had been prepared! Its chemical structure is not fully known, but it is certainly quite different from animal hormones, and no animal hormone when applied to plants has been known to increase their growth. Despite this dissimilarity in composition between plant and animal hormones, the best source of auxin is not from plants at all, but from human urine. Urine contains from one to five million " Oat Units " per gram, and nowadays auxin is prepared from this source. Its occurrence among plants is not confined, of course, to oats. It is produced in the growing points probably of all plants, though it may vary somewhat in composition. The chemists have purified and produced as crystals two modifications of auxin—auxin *a* and auxin *b*. A third kind of auxin is present in moulds and other kinds of fungi, and is known as hetero-auxin. This has an entirely different chemical structure, and is especially interesting because it can be synthesised in the laboratory. It is an acid, β-indolyl-acetic acid, and can now be bought as crystals and used for growth hormone experiments. Its potency is about the same as that of the two forms of auxin.

We may now return to our initial experiment and ask how the bending of a coleoptile (or shoot) toward the light depends on auxin. One of Went's experiments showed that the same sort of bending could be produced by putting a block of auxin-charged agar on one side of a coleoptile stump; so it seems reasonable to suppose that the bending toward light is due to the production of more auxin on the side of the coleoptile away from the light. This could happen in two ways: more auxin might be produced on the shady side than on the bright side, or auxin might diffuse away from the light toward the shady side.

A simple experiment (too difficult to perform at home) answers this question. A coleoptile is split down the middle and a thin piece of mica inserted in the split. The coleoptile is then illuminated from the direction indicated by the arrow in the illustration. Now if the effect of light is to drive the auxin over to the shady side it will be prevented by the mica strip. The result will be no bending of the coleoptile. If, on the other hand, more auxin is manufactured on the shady side, the mica will make no difference: bending will take place as usual towards the light. When this experiment is carried out the result is decisive. The coleoptile does not bend. Therefore light affects the movement of auxin and not the amount manufactured. We may summarise the sequence of events when an oat coleoptile is illuminated from one side in the following way:—(1) lateral illumination causes migration of auxin to the shadier side of coleoptile tip; (2) a consequent increase in concentration of auxin on the shady side, (3) more auxin diffuses down to growing tissue on the shady side than on illuminated side, and (4) tissue on the shady side grows more than tissue on the illuminated side: therefore bending toward light occurs.

This is only the beginning of the remarkable story of plant hormones, for this same auxin which stimulates



The growth hormone will pass from the tip to the stump through agar jelly; it may be collected from oat-tips in agar jelly; a block of the " charged " jelly will then stimulate growth; and also movement, if placed on one side of a tip. Under normal conditions growth hormone passes across the tip, and is prevented from doing so by a strip of mica. For further explanation see above.

growth in the coleoptile of oats and the terminal buds of ordinary plants has precisely the opposite effect on roots. Lay a bean seedling so that its root is horizontal and the root will turn downwards in a few hours. But if you remove the root tip before doing this experiment there will be no turning: the root grows straight on. The explanation is simply this. Hormone produced at the tip diffuses to the lower side of the root under the influence of gravity. Where the hormone accumulates

growth is prevented! Growth continues normally on the upper side: consequently the root turns down.

We require some proof of this surprising statement, and we require to know whether the hormone is auxin or something else, particularly as its effect is precisely

A root turns downwards under the influence of gravity (left), but is prevented from doing so if coleoptile or root tips are put on the upper side of the root. Under these conditions the root may even turn upwards (centre). No response to gravity occurs if the tip of the root is removed (right).

the opposite to that of auxin on stems. You can supply the proof in a simple experiment. Germinate some beans, and when the roots are about half an inch long take some which are straight and divide them into two lots. Make a damp chamber from a wide-mouthed bottle lined with damp blotting paper. Pin the first lot with their roots horizontal, on a piece of sheet cork inside the bottle. Pin a second lot in the same way, but cut off the root tips first, and stand three coleoptile tips from oat seedlings along the upper side of the bean roots. Then cover the jar and leave it for three hours. At the end of that time you will find that the untreated bean roots have grown downwards, but the roots with coleoptile tips on them have turned upwards! Auxin from the tips has diffused into the upper side of the roots. There is no corresponding accumulation of auxin on the lower side, because the root tip was cut off. In contrast to the stem, where the auxin has accumulated growth is suppressed, so the root grows upwards in defiance of gravity.

And thus the story might be continued, for auxin controls not only the response of the plant to light and gravity, but, by controlling the shooting of buds, even its shape. There may be other hormones in plants beside auxin, perhaps a hormone influencing reproduction, as in animals; but as yet we know only one.

Locusts of Timbuctoo

(*Continued from page* 169)

The measurements of the 346 specimens indicated that only about half were true *solitaria*, and that the remainder were what are termed *transiens*, and were half-way between the two extreme phases. There was nothing to show whether they were grasshoppers becoming locusts or the remnants of swarms becoming grasshoppers. This was in May, and when I next visited Diafarabe in September we collected 283 specimens, and the measurements indicated that the May *solitaria* had now become *transiens* and the May *transiens*, although still intermediate, were nearly true *gregaria*. Space will not permit any description of the similar investigations in all the other localities that we visited, but sufficient has been said to indicate how the following conclusions were reached.

Phase *solitaria* thrives in the plains of the Middle Niger, and his home is really in the belts of the *dhub* grass whose evergreen foliage offers nourishment throughout the year, and in the tufts of this grass the grasshopper can find sanctuary from bush flies and insectivorous birds. The largest expanses of *dhub* are in the neighbourhood of Diafarabe, and here it was seen that even in the fairly normal wet season of 1932 there was a tendency for phase *gregaria* to develop. Given suitable conditions, the stage is always set for the transformation, and the variables that may effect this change are climate and river floods. A detailed analysis was made of all meteorological and river height records, and from the mass of figures two facts emerged. In the years 1926 and 1927 the rains were not typical; they began rather early and very suddenly, and the early rains were particularly intense. In 1926 the maximum height of the flood was well below average, while in 1927 it was again slight.

My general conclusion is that during 1926-27 the climate suited the grasshoppers particularly well, and because of the sudden arrival of the rains in both years the breedings of the increased population coincided, while the low floods left islands of *dhub* where the hoppers or adults could congregate. The result was the appearance of swarms in 1928.

All this is admittedly rather vague hypothesis, and many more facts will have to be collected before we can with certainty foretell how freaks of climate and flood will react on the solitary phase. Something has, however, been learnt. We know where this locust comes from, for he has been followed home to the Middle Niger, and there traced back to one type of grassland. Unless my conclusions are far from the mark, we can at least keep a careful watch on the harmless grasshoppers, and if a change is observed, then the African colonies under all flags will have to unite to finance a unique international crusade. I shall be envious of those who are in at the death, but I shall have some recompense in memories of those six months of exploration.

Bird Photography for the Amateur

By G. A. Coaker

Neither expensive apparatus nor great experience are needed to procure good photographs of bird subjects. Those published with this article were taken by the author with the simple apparatus he describes.

A YEAR or two ago I took up bird photography. I had always been interested in birds, but had imagined that actual photography took a great deal of time and money. However, I bought a folding Kodak roll film camera for £4, which, in addition to the ordinary shutter device, had a distance release, enabling the photographer to be at a distance from the camera. Besides the camera, a tripod is necessary, and I have found a little device, called a Kodapod, extraordinarily useful for fixing the camera on a bough or gate post. Most people prefer plates to roll films. Plates are heavier and more bulky, but are easier to deal with in developing. Supersensitive Panchromatic films are the best to use, as they are very fast, though in a good light Panatomic films are useful. They are rather slow, but very good for enlarging.

A lapwing near its nest

Having purchased a camera and tripod, and decided what plates or films to use, the question of a "hide" arises. For photographing birds in the open, such as waders at their nests, I use a hide made of two old ground-sheets, sewn together, stretched over a cross-bar, and pegged to the ground on either side. It has the appearance of a miniature tent, and in it I lie on my stomach. At the foot end there is a flap, which is tied down firmly when I am inside, and at the head end I place branches, heather, or some other suitable material. On either side there is a small peep-hole, and a small gap is left in the front. All ends are securely tied, so that they do not flap about in the wind and frighten the birds. When I am comfortably settled, I get a friend to walk away in full view of the birds. When the nest is unsuitably placed for a hide, such as in a tree, I use the distance release. When using it, very little camouflage is necessary. I put a drab-coloured mackintosh cover over the camera, and hide myself, with the aid of a few leafy branches or bits of heather, in a bush, or behind a hedge about twenty or thirty yards away.

The next question that arises is what bird to begin photography with. Swans make a very good subject, as they are large, white, easy to approach, and usually found in the open away from shadows, etc. If you wish to start during the winter months the bird table supplies many subjects, all easy to photograph. The chief difficulties to be overcome are to get the camera the right height, and to get a good background. When I was photographing my bird table I used the distance release, and sat in a sitting-room window. Five minutes after the camera and tripod had been in position robins and blue tits were perching on them unconcernedly. One blue tit took a photograph of a great tit by perching on the release line, and so operating the shutter.

If you wish to start on a bird at the nest, the lapwing is about the best. The nest is in the open on the ground, and the birds are not worried by a hide. I find that when using a proper hide it is best to put it up in the evening, just before it gets dark, and and then the birds do not really notice it until the following morning. I usually place it about thirty feet away at first, and move it up to within six feet in two stages, about five days apart. It is best not to leave it in position too long, for then the lapwings get so used to it, that they brood facing in the opposite direction.

Kingfishers are another excellent subject to begin on. It is usually useless to try and photograph them on the actual nesting hole, as they do not pause there long enough, before going up to the nesting chamber. When I was photographing a nest, I placed a dead bough in the river, near the nest, for the kingfishers to perch on before and after feeding the young ones. When it had been in position a fortnight I went down and made a hide in the alders on the bank. I placed the camera on a tripod in the river, about three feet away from the bough. The old birds were soon busily engaged feeding the young, often making use of the perch. They used to remain in the same position for long intervals, and

so it was easy to get sharp photographs of them.

If you have not got time to photograph adult birds from a hide, nests and young birds provide very good subjects. When photographing nests the camera should be stopped down, and a long exposure given, to get in as much detail as possible. This cannot be done with the birds themselves as there is always the fear of movement. With a camera which will focus down to three feet, by stopping down the lens on a dull day, and giving a time exposure, good results can be got from only two feet away. Of young birds, owls and kingfishers are the most attractive subjects, as they will often "sit" nicely.

If you are more ambitious I recommend using a plate camera. It is best to get one which has a double extension, as this enables you to focus down to six or seven inches, which is very useful for taking photographs of small nests, etc. It can be worked by distance release very simply. The method I employ is to attach a rubber band over the shutter lever, and fit a wire hook to hold it up. When this is pulled away by means of cotton the shutter is released, and a photograph taken. Really good second-hand plate-cameras can be bought quite cheaply. If you are going to carry the camera about much, one that takes $3\frac{1}{2}'' \times 2\frac{1}{2}''$ pictures is best, as larger ones are very heavy, and the plates very bulky.

Bird photography need not end at the close of the nesting season. There is always the bird table, and the making of lantern slides for use with lectures, and surely a good collection of slides is better to look back on than a so-called good collection of eggs?

The great spotted woodpecker (above) about to feed its young; the young kingfishers and the adult bird with food, were photographed from an alder-bush "hide"; the young tawny owl (bottom right) was taken out of its nest to be photographed.

Radium in Canada

By V. S. Swaminathan

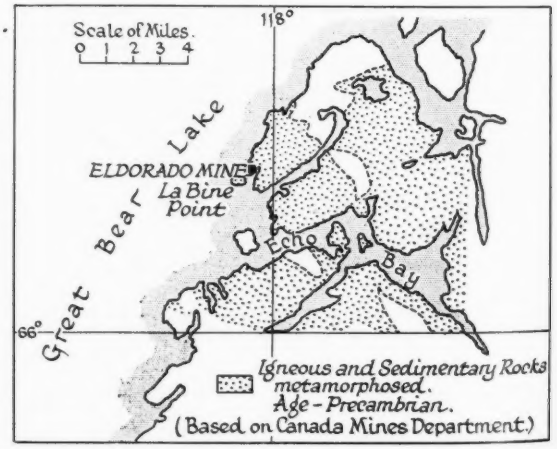
Medallist, Mineralogical and Geological Institute of India.

THE production by Canada of radium has, after more than three years of intensive development and research work, now been established as a sound commercial proposition. The enterprising Eldorado Gold Mines, Ltd., working under arduous and adverse climatic conditions in the far-off north-west territories of that New World Dominion, deserves all the credit for this achievement. At present it is the Empire's sole producer of radium and uranium salts, and what is more, according to the 1937 programme it should lead the world in radium production. Radium was first isolated from pitchblende, an ugly-looking black mineral resembling pitch in colour, lustre and fracture, only far heavier than pitch with a specific gravity ranging from 8.0 to 9.7. Pitchblende is an oxide of uranium and contains, besides, varying amounts of oxides of other rare metals. It is the richest ore of radium, the latter forming one part to five million parts of uranium. Other rare minerals, such as carnotite, also carry radium, though in much smaller amounts.

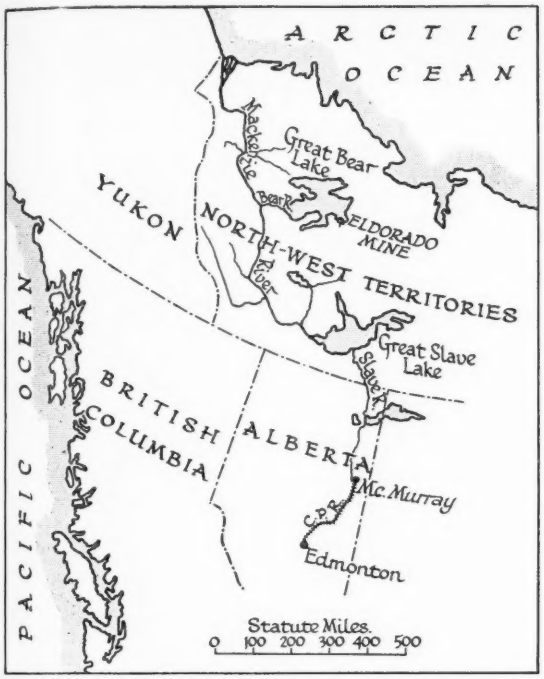
Pitchblende has been found in limited quantities at the Trenwith mine, St. Ives, in the adjoining St. Ives Consols mine and the South Terras mine in Cornwall in association with tin and copper ores; in the Joachimsthal district in Czechoslovakia with silver and copper ores; in Norway in pegmatities; in much larger amounts at Katanga in the Belgian Congo with copper ores, and carnotite occurs in Colorado and Utah, U.S. The Canadian deposit is found alongside of silver ores. The U.S. carnotite deposits were the principal source of radium before the immensely rich Katanga deposits were discovered, and the latter dominated the world market till last year. The Canadian pitchblende property now under active development will, before the close of the current year, take the place of Katanga. To attain this position an enormous amount of hard work had to be done by the Eldorado Gold Mines in the four distinct fields of mining, transport, refining and marketing and the first three fields presented truly formidable problems.

To start with, the Company satisfied itself that the geological structure at depth was favourable, and the ore reserves in sight ample, before embarking on a long-term programme of development. Mining and milling operations were pushed forward vigorously and the underground development work was speeded up by a crew of 85 men. The shaft was sunk down 500 ft. below the adit level, and the 375-foot level opened laterally by a cross-cut. The mining engineers were more than gratified with the width of the vein and the richness of the ore encountered on the 465-foot level. Towards the end of 1936, electrification of mine and concentrator operations at Great Bear Lake in the Canadian sub-Arctic was completed. The distance from the mine at La Bine point to the refinery at Port Hope, Ontario, is more than 3,000 miles and the railroad ends 1,450 miles before La Bine point. Efficient and economic air services—weather permitting—are now in operation over this last lap. Also, navigable waters of the Mackenzie River system flowing into the Arctic ocean, drain the area in which the property is located, enabling the freight of concentrates out and equipment and stores in from the railhead at Waterways, Alberta, to the mine's own wharf only a few steps from the mine-shaft. With a view to further reducing costs and increasing efficiency, the Eldorado Gold Mines, Ltd., have purchased the Northern Transportation Company's motor boats and barges, and are operating them on their own account. The mining activities of the Company were delayed somewhat last June due to the late break-up in the Upper Mackenzie River system. Eldorado proposes to produce a sufficient tonnage of pitchblende concentrates and silver ores to be transported by water during the short navigation season to meet the 3,000-mile distant refinery's increased needs for the full year.

The extreme rarity of the pitchblende ore and the highly complicated and costly processes necessarily involved in the extraction of the infinitesimally small



The situation of the mines on the shores of Great Bear Lake.



The line of communication between the mines and the refinery 3,000 miles away at Port Hope, Ontario, includes a 1,450 miles stretch beyond the railhead at McMurray, which is covered by air services.

quantity of radium it contains, combine to explain the high cost of radium. The Canadian company, at this stage, was confronted with the crucial problem of refining pitchblende. If the Eldorado ore was regularly indicating a richness in radium content never previously recorded in commercial operations, it simply made the task of treating it the more difficult, as the chemist and metallurgist attached to the Company could get no real assistance from corporations already in the field elsewhere in the world. The preliminary processes were successfully worked out in the laboratories of the Federal Department of Mines, Ottawa. Mr. M. L. Pochan, who had previously worked in the Curie laboratories, came over to Canada from France to take charge of the work, and the methods of Madame Curie were successfully adopted, with modifications, for the production of radium from the Canadian pitchblende.

The result was that, by October, 1936, Canada's radium production reached two grams monthly for the first time, and on November 16th last production of the first ounce—28 grams—was completed. In the following month the Company launched its expansion programme (which when complete is expected to more than triple the refinery capacity) necessitated by the rapidly increasing demand for radium, particularly from Britain and the Empire countries.

The price of radium has been halved as a result of the stabilisation and expansion of the output following the development of the Eldorado property. The Company considers the present price levels (metal of milligram radium content costs $40.00) extremely satisfactory from a commercial point of view. Nor does it forget the humanitarian services to which their product is used.

Early Man in Asia

An important symposium on Early Man was held recently at the Academy of Natural Sciences of Philadelphia to mark the 125th Anniversary of the Academy. Among the British representives attending were Miss Dorothy Garrod and Professor V. Gordon Childe. Considerable interest was aroused at the opening session by a group of papers of special significance in their bearing on the problem of the evolution of man, and the dating and distribution of early forms of his culture. They opened with a survey of man's geological record in Java by Dr. G. H. R. von Koenigswald, official palæontologist, Java Service, followed by an account of the palæolithic industries of China by Mr. W. C. Pei, who discovered the first Peking man skull in 1929. This communication was notable as the first comprehensive survey of the material to be submitted to a western audience. Mr. Pei classified the main palæolithic industries into four groups; but he also referred to two earlier industries which had been recognised by the Abbé Breuil, the Nihowan, represented by one worked stone and some worked bones, dated as Upper Pliocene and equivalent to the Villefranchian of Europe; and Locality 13 industry, represented by a chert implement of undoubted human origin, belonging to an early phase of the Lower Pleistocene and corresponding to the Abbevillean of France. Of the four main industries, the Sinanthropus, which may safely be said to begin the true industry of China, belongs to the Lower Pleistocene and is attributed to the Abbevillean in the French palæolithic sequence. It is followed by the newly discovered and little studied Locality 15 industry from Choukoutien, the cave which was the home of Peking man. This industry may belong to the early Middle Pleistocene, and corresponds to the Late Lower Palæolithic of Europe. The Ordos Industry, so called from the finds in the Ordos desert, is contemporary with part of the Chinese loess and may be attributed to the Late Middle Pleistocene; while the Choukoutien Upper Cave industry represents the Upper Palæolithic of Europe, corresponding to the Aurignacian, Solutrean and Magdalenian in the European succession.

British Scientific Instruments

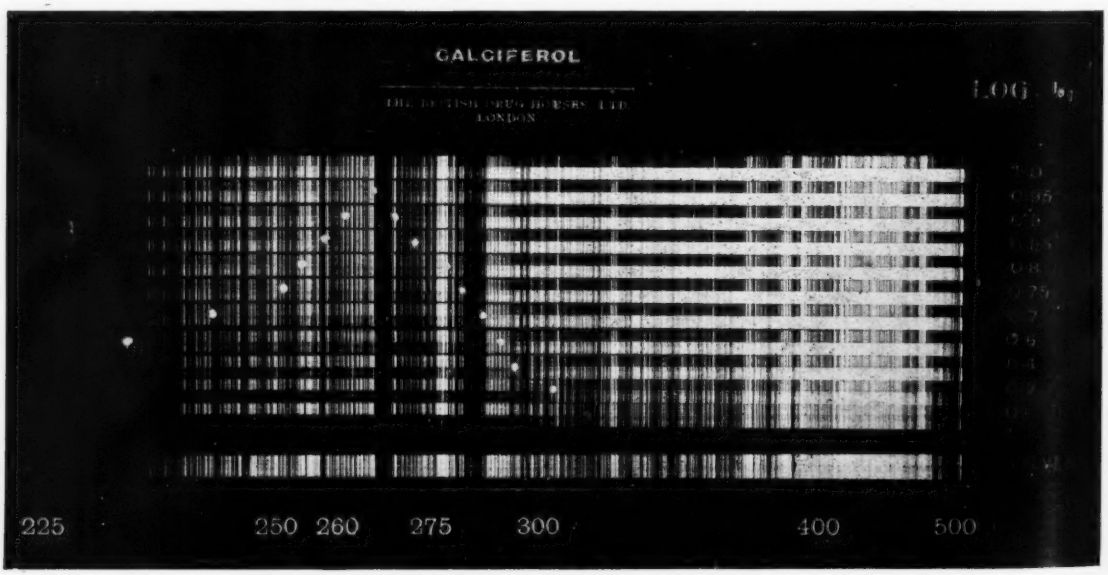
Optical instruments are taking a leading place in industrial measuring and the detection of flaws and impurities.

THE progress of scientific activity is in many respects dependent on the accuracy and precision of the instruments and apparatus with which the scientist is able to work and on the range of instruments that is made available to him. Industry in turn makes increasing demands of science, and there can be no gainsaying the important part which scientific instruments are taking in modern industrial efficiency. Of the instruments, those concerned with optical work take a position of primary importance, and it is fitting that "Optical Devices in Research and Industry" was the subject of a conference, convened by the Institute of Physics, held in Birmingham earlier this year.

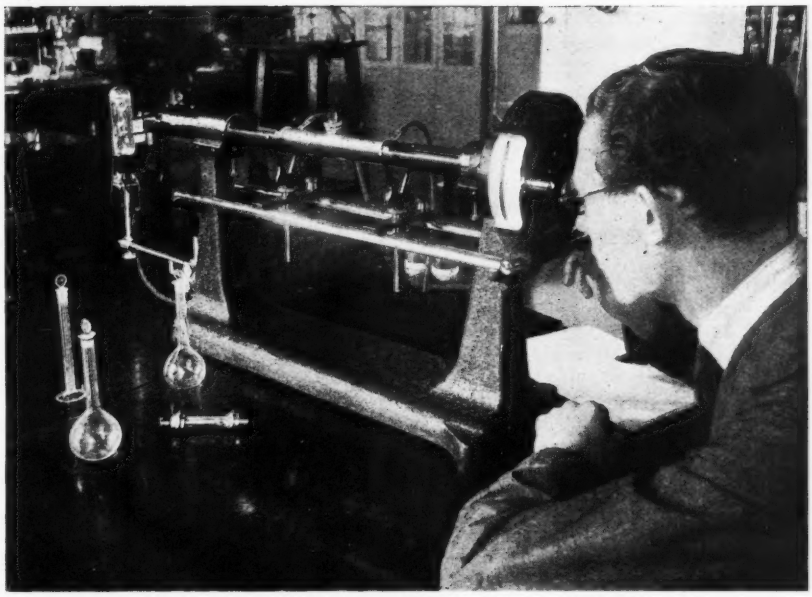
As Dr. Harry Moore, Director of Research of the British Scientific Instruments Research Association, has stated, optical instruments have been adapted or developed for a wide variety of purposes. To take only a few examples, they are used for the accurate gauging of screws, for testing the profiles of screw threads and of pivots and jewels, and for the measurement of thickness to within one or two ten-thousandths of an inch, replacing progressively the various mechanical gauges formerly used for these purposes. For colour measurement, instruments are now available which will express the colour of a fabric in such a way as practically to identify the dyes used in colouring the fabric, so that the colour can be duplicated and not merely matched.

The usefulness of the polariscope in industrial processes involving the control of sugars is well-known, but the application of refractrometric work to observe the progress of essential processes in the production of plastics may not be so commonly known. Similarly, optical instruments are now being used for the detection of impurities present in proportions which might even confound the chemical analyst. It is possible, for example, to determine whether or not steel contains as little as one part in 100,000 of chromium, a proportion which, though extremely minute, is sufficient to affect appreciably the magnetic properties of the steel.

The more spectacular uses of photo-cells, such as in television, as burglar alarms, for the sorting of coloured objects, and for counting components produced by automatic machinery, etc., have lately been described in DISCOVERY (Nov., 1936). Such cells are also used in colorimetric work and in photographic exposure meters. Dr. Harry Moore advances the view, however, that from a more general point of view, perhaps the most important of their applications is for measuring the illumination in factories and workshops, so that adequate illumination, which is essential not only to productive efficiency but to the health of the workers, can be ensured.



Absorption spectra of calciferol.



Polarimeter in use in the British Drug Houses Laboratories.

Chemicals used as reagents in analytical work must be of a sufficient degree of purity to ensure that in every case they will give the desired reaction and will not introduce impurities which will make their appearance at a later stage of the analysis. As an illustration of the risk of being misled by impurities present in reagents an instance which occurred some years ago may be cited. Research was being conducted in various laboratories with a view to finding a reliable colour test for vitamin A in cod-liver oil, and it was found, and for a time was accepted, that trichloroacetic acid gave a blue colour with the vitamin. Efforts were made inanalytical laboratories to apply this as a quantitative method, when it transpired that although good colours were obtained with an impure acid, no colour whatever developed when a highly purified trichloroacetic acid was used. Further investigation showed that much of the trichloroacetic acid in use contained traces of phosgene and that it was the presence of this impurity that caused the colour formation.

Traces of impurities that catalyse reactions may lead to erroneous inferences ; for this and many like reasons it is of the greatest importance that analytical reagents should be as free as practicable from all impurities. Absolute freedom from impurities, however, can only rarely be achieved and purification to the point necessary for analytical purposes is only effected in a few chemical substances which are produced on a commercial scale ; consequently the manufacturer of reagent chemicals must purify them specially and work to a specification which strictly limits and defines the permitted amounts of impurities. Manufacturing operations must be carried out under very strict conditions of analytical control, employing varied and repeated processes of purification carried on until the full specification is complied with. Such chemicals can then be supplied with a guaranteed statement of the maximum limits of the impurities which may be present, so that the user knows exactly the maximum amounts that may be introduced in the course of his work.

The methods of manufacture of such chemicals do not necessarily differ from those adopted in making the ordinary pure grades, but they must proceed with constant repetitions. Impurities are removed by precipitation or adsorption, wherever possible, and in many cases recourse has finally to be had to processes of repeated recrystallisations with temperature control under conditions of fractionation.

From the beginning to the end of the manufacturing stages strict analytical control is essential, and the final product before being passed into stock must conform to the particular specification in all respects. In spite of all this care in manufacture it is of supreme importance that a final analysis should be carried out in a laboratory quite distinct from the one attached to the manufacturing department where the process samples are tested. By this arrangement a double check is provided. Although chemical analysis is relied on for most of the commoner inorganic reagents, it is necessary in some cases where extreme purity is required to resort to spectroscopic analysis, either in the visible or the ultra-violet region, or in both. The quartz spectrophotometer is used for this purpose and also for the examination of certain organic substances for which no satisfactory chemical tests are available, as, for instance, calciferol or synthetic vitamin D. In such cases, it is usual to determine the absorption coefficient of a solution of the substance in some optically transparent solvent. By the extent of the absorption at particular wave-lengths the substance can be identified and evaluated.

The actual process involved in determining the absorp-

tion coefficient consists in taking, on the same plate, a series of pairs of photographs of the spectra produced by the light of a high tension spark from tungsten steel electrodes passing through 1 centimetre depths of the solution and of the solvent. By means of the photometer, the amount of light passing through the solution is progressively increased for each pair of the series and the dark slide is adjusted to expose a fresh portion of the photographic plate. The developed negative shows a number of spectra arranged in pairs in which the ratio of exposures of the two halves of each pair varies according to a pre-arranged plan. On this, the absorption curve is plotted by marking off the points of each pair that are equal in intensity.

For the detection and determination of traces of metallic impurities, the substance to be tested is "sparked" between copper electrodes or on a carbon arc. The elements present are then detected by the position of the spectrum lines, and the quantities may be determined by comparing the intensity of the lines with standards prepared from known concentrations. This method is used for the detection of minute traces of barium in strontium salts and lead in thallium compounds. Spectroscopic measurements in the visible region as obtained by the spectrophotometer are also used to identify and evaluate certain coloured organic reagents such as microscopic stains, and for the detection of didymium in cerium salts.

Many organic chemicals used in research are optically active and their rotation as determined by the polarimeter is a useful criterion of their purity. It frequently happens that such substances are very expensive and only a very small quantity is available for testing, or the substance may be sparingly soluble, so that in either case, the determination must be carried out on a very dilute solution, 1 per cent. or less, and this necessitates an instrument of a high degree of precision. As the optical rotation is affected by temperature, water-jacketed observation tubes are used.

During recent years, an increasing number of complex organic reagents producing well-marked colorations with certain metals have been found to be of use in the determination of traces of these metals. In the examination of these reagents it is of the highest degree of importance that they shall be uniform in their action; it is essential therefore to carry out quantitative colour tests to ensure such uniformity. For this purpose, the tintometer is found to be invaluable, but it is absolutely essential to standardise the test, as most of the colours produced are either evanescent or due to matter in a colloidal state and very slight alterations in procedure often produce different shades or depths of colour.

BRITISH ASSOCIATION NEWS

The City of Nottingham

NOTTINGHAM, the city which the British Association is to visit this year for its annual meeting, combines interests old and new, ranging from the sandstone caverns of the ancient British tribes to the wonderful new works of Messrs. Boots, the Cash Chemists. It is by no means a new thing to meet in Nottingham; in 1866 the Association met there under the presidency of W. R. Grove, and in 1873 under that of Professor J. S. Burdon Sanderson. Since those days the city has developed considerably, and the population to-day is estimated at 276,500, covering an area of 16,166 acres.

Nottingham is rich in historical associations. In 868 it became one of the five burghs of the Danes, along with Lincoln, Derby, Leicester and Stamford. From then on, the town changed hands many times. In 910 Edward the Elder built and strengthened its defences with a wall, and built a bridge over the river Trent, at Bridgford. During the reign of Athelstan (925-940) a mint was established in the town, where money was coined up to 1154.

When William the Conqueror took possession he built a castle on the rock which overlooks the Trent, and although the town itself was twice destroyed by fire in 1140 and 1155, the castle remained undamaged. Edward IV was proclaimed King in Nottingham (1461). It was from Nottingham in 1485 that Richard III set out to cross the Trent for Bosworth Field, where he was defeated by Henry, Earl of Richmond, and slain.

The Arms of the Association.

The Association has received a grant of armorial bearings from the College of Arms, the incidental costs being met by the gifts of an anonymous donor and of ex-Presidents of the Association. The blazon is as follows: *Arms:* Azure ten stars, two of six, four of five, and four of four points Argent (representing the constellation Libra) over all a Balance Or. The Motto, *Sed Omnia Disposuisti*, is taken from *Wisdom of*

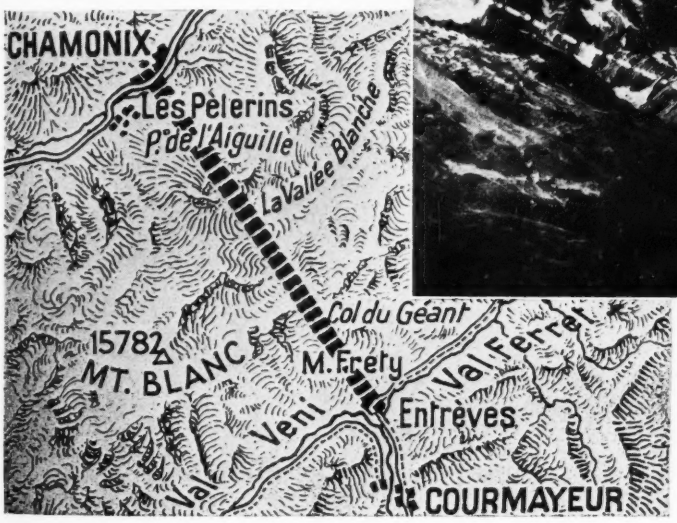
Solomon, ii, 20 ("But Thou has ordered all things in measure and number and weight.").

It is announced that two lectures delivered annually under the auspices of the British Science Guild are to be continued by the Association. The Alexander Pedler Lecture given in Leicester on May 3rd, and the Norman Lockyer Lecture will be given in the Goldsmiths' Hall, Foster Lane, E.C.2, on November 24th, at 4.0 p.m., by Dr. R. E. Mortimer Wheeler, upon a subject connected with the Roman period in Britain.

Mont Blanc Road Tunnel

By Karl Egli.

THE prophecy of the great natural historian De Saussure (1740-99), that a day would come when a tunnel would be driven through Mont Blanc, seems likely to come true. Swiss, French, and Italian interests are combining to work towards the end which he forecasted. Though only France and Italy are immediately concerned, Switzerland (and especially Geneva) is interested in the scheme since the most direct line between Rome and Paris runs through Geneva and Chamonix.



The new road tunnel is planned to begin 700 ft. above Chamonix and to run for more than seven miles in a direct line straight through Mont Blanc, to emerge near Entrèves in the Aosta valley. There would be two roadways to avoid the crossing of traffic within the tunnel.

From its point of departure near Chamonix, 3,400 ft. above sea-level, the new road would enter a spiral tunnel about 1,100 yards long, and continuing along the edge of the massif, would enter a second spiral tunnel, some 2,2000 yards long, which would bring it to a height of a little over 4,000 ft. above sea level-after 5,500 yards. Then, cutting straight through the massif under the Roc de la Vacherie, the Aiguille du Plan, and the Vallée-Blanche and Géant Glaciers, the road would debouch, at a height of 4,400 ft. on the Italian-side, on the road leading from Entrèves to Courmayeur and Aosta. The total length of the new road from Chamonix to Entrèves would be about twelve miles. The relatively low elevation of the tunnel mouths would obviate the danger of serious accumulations of snow, and would enable the road to be used throughout the year.

No geological difficulties are expected. It is probable that large quantities of water might be struck, but this does not daunt the experts, as they count on using the water to get rid of the excavated rock.

The cost of the tunnel is calculated at about 300,000,000 French francs and would be met, in the first instance, by public loans. Assuming an average of 100,000 vehicles per year passing through the tunnel, the revenue from a moderate toll should suffice for redemption of the loan, payment of interest, and maintenance. Even at the start, the tariff of tolls would be lower than the charges at present in force for the transport of motor-cars between France and Italy and Switzerland and Italy by rail, at times when the mountain roads, such as the Simplon and the Mont-Cenis, are closed to wheeled traffic, a period which may last as long as from early November to late May.

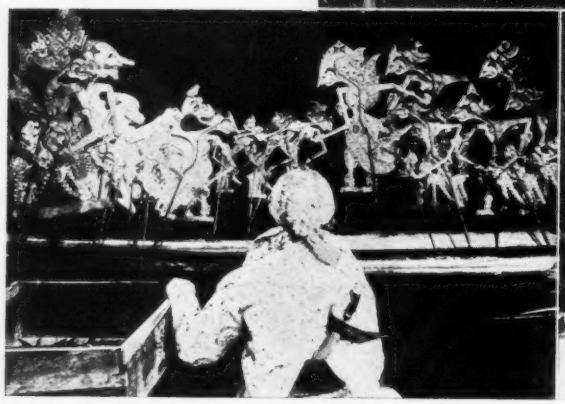
JAVA PUPPETS

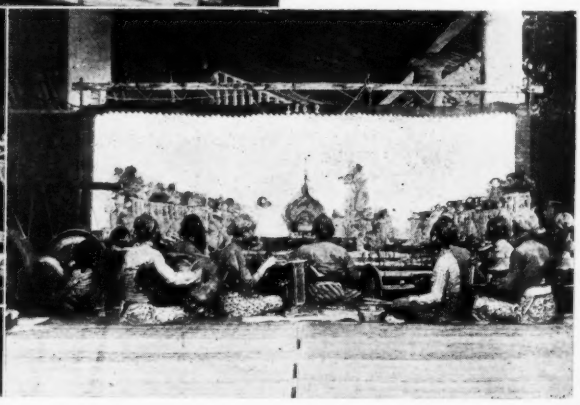
A Play of Good and Evil

In the puppet-maker's workshop (below) the gods and demons are carved in wood and painted in bright colours. Typical puppets are the symbol of the demons (left) and the divine princess (right) who takes an active part in the fighting.

The "Dalang," who directs the war (below) wears the kris or Javanese dagger in his belt.

The stage is very primitive. The principal task of the orchestra (below) is to support the war cries on the stage.





PUPPET shows have been developed into an art in Java. The plays have fantastic plots, all based upon ancient mythical sagas of the Indian Mahabharata, transcribed with the real Javanese spirit. It consists of the struggle between Good and Evil, "Pandawas" and "Kurowas." The former are supposed to be the sons of the God Vishnu, whereas their adversaries are the demons and their princes.

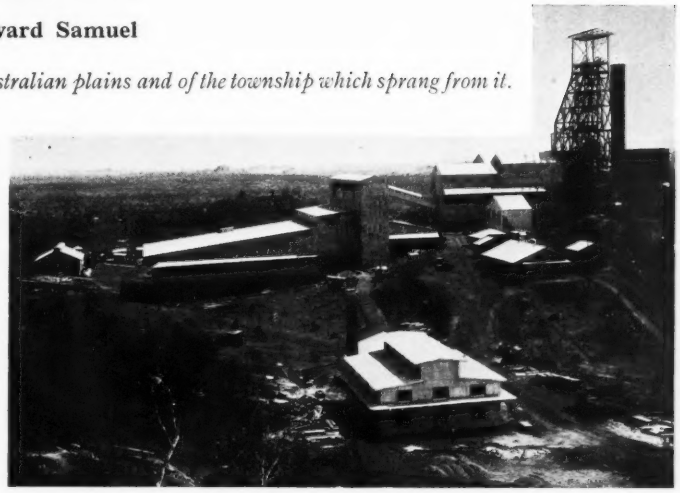
Here the godly princes and princesses and the much stronger army of demons face each other, the latter weird, mischievous figures. The bad elements, who are in a great majority, threaten to conquer the good; however, at the decisive moment, when all seems lost. Vishnu descends to earth in the form of a combatant and destroys the demons.

That is the plot of the play, the acting of which takes many hours. The Javanese is indefatigable in his admiration and listens with rapt attention to the war-cries of both parties. The puppets have a quaint appearance, with their long necks and slanting eyes and their excessively broad shoulders, but the clever hand of the Dalang, the showman, infuses them with life. The mechanism is very primitive indeed, the sticks being fastened to the puppet's hands.

Mount Isa

By Edward Samuel

The story of a modern "lucky strike" on the Australian plains and of the township which sprang from it.

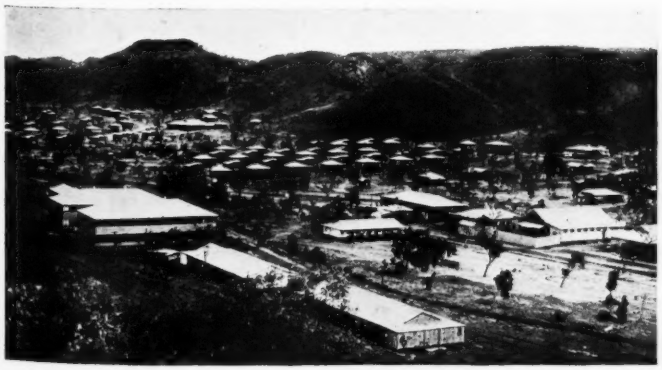


The ore haulage shaft headframe and mill, with the assay office in the foreground.

LITTLE more than ten years ago Mt. Isa, in North West Queensland, 600 miles from Townsville, was unknown and nameless. It was a mere hill in the "never never," a unit in a range of reddish hills bearing scanty spinifex vegetation. To-day Mt. Isa is a name synonymous with a gigantic mining venture, in which the world has found a new supply of lead, silver and zinc. This possibility of centering at Mt. Isa mining operations on a wholesale scale entitles it to be regarded as the world's biggest discovery of lead in recent years. It is being developed by a company with a capital exceeding £2,000,000. This once desert country has a town with a population of six thousand people; it has the world's best mining machinery, and the weekly pay roll of the mine itself exceeds £10,000.

In 1923 a lonely and almost penniless copper prospector was vainly searching for a lost horse in the waste land of the north west. He climbed a high hill and flung himself down to rest. He poked the red stained earth with his knife in quite an aimless manner. A lump of rock was dislodged and rolled against the knife. The clink of this rock against steel has been heard and heeded by the biggest mining financiers of the English-speaking nations. Mt. Isa has been a magnet which has drawn thousands to that spot. The rock was simply a typical sample of the rich ore deposits since found there; the lonely fossicker was John Cambell Miles, of Melbourne. He very nearly failed to take advantage of his luck, for he had no idea what the rock was and picked it up to toss it down the hill. Its weight made him pause, and he recollected having been told by an old fossicker of the remarkable outcrop in the hills between Cloncurry and Camooweal. Curiosity prompted him to collect a parcel of similar rocks that covered the hills, and he returned, after a vain hunt for his horse, to his camp on the Leichardt River, and he showed his samples to his mate, W. J. Simpson.

Miles lost all interest in the rock he had collected and he very nearly dumped the lot. Once again curiosity came to the rescue, and he sent the bundle to the assay office at Cloncurry. The report which came back was fairly encouraging, and he was induced to collect six tons of stone and send it south for smelter treatment. He did not even climb the hill, but merely had to collect scattered outcrop stone. The ore was lying all over the ground, and Miles and his mate simply shovelled it up. Neither of these two adventurers had any funds; all their worldly wealth was their copper gouger's outfit, and they left the district and went across the Gulf country into the Northern Territory. Sheer necessity forced them to abandon prospecting and seek work on the cattle stations near Darwin. The hill that was to be Mt. Isa was completely forgotten.



A bird's eye view of the Mount Isa township.

Six months passed and this Golconda remained a wilderness in a forbidding line of hills and ranges. Once more Miles turned up

at Cloncurry and casually asked for his mail. There was a letter for him, the analysis of the despised parcel of ore sent south. The dirty stuff he had "bagged" with such nonchalance was full of lead and silver. Realising that he had made a strike, Miles held his tongue, and with Simpson raced out to the field. They pegged out two leases, one on the hill where the first rock had been discovered, which Miles named Mt. Isa after his sister, Isabelle. The other lease was called "Racecourse" because the folds of the hill gave it the appearance of the bend into the straight of a racecourse. Legal formalities completed, the news spread. For a while it created no interest; most people were sceptical and Miles and Simpson were a laughing stock. Gradually, however, one or two old hands went away to think and disappeared. They came back and registered claims—after that pack horses, donkey waggons, mules, and motorcars rushed out, and soon 500 men were searching for the lode. Many lost their way in an exciting race; they had no idea where the promised land was and the country was deceptive and waterless. Many never saw the field until the railway was opened and they were too late. Some were never seen again.

Twenty Square Miles "Pegged"

Pack horses proved more trusty than motor cars, as they could take the direct route over the hills; the cars were handicapped by constant punctures, and the wayside was strewn with motor tyres and broken down cars. In spite of this the 500 speculators who did arrive at the post drove their pegs as near as possible to the centre of discovery and then returned to civilisation. At the hill, country was quickly taken up, while the low country where the largest and most profitable lodes were discovered, was neglected. This gave the late arrivals a wonderful chance. An area of eight miles in length by about three miles in width was pegged out in the first rush.

The Mines Department then intervened, as in their greed some men held as many as eight leases. A resurvey was ordered and it was decreed that no single person could hold more than one lease of ten acres together, with an original prospecting lease of fifteen acres. Mount Isa was launched; the stake holders were given their choice of the many leases they held. The story is told of one of the first men to get on the field after Miles and Simpson. He spent thousands of pounds drilling and shaft sinking, found nothing and abandoned it. Next to his lease was found the Black Star lode, perhaps the biggest low grade silver lead mine in the world to-day.

Miners took out their families in the waggons which they lived under, and built shacks of scrap iron and logs. Some of them sheltered families for years. They are the landmarks that tell the visitors to the township of to-day, with its shops and hotels, of the trials and difficulties of early arrivals only so few years back. Some grasped opportunity, many let it slip. One man gave away a lease at Mt. Isa for a cowhide and found later that it had been sold for £40,000. This man was Simpson, one of the two original pioneers. He did not complain; the cowhide was badly wanted for making collapsible water and feed buckets for provisioning his horses. This equipment was dear, but he held on to an even better claim.

Two companies were formed in the Cloncurry district to exploit the latent wealth of Mt. Isa. Later on these were joined into a huge merger that bought in considerable Southern capital; finally the Russo-Asiatic Company, by the purchase of a large block of shares, obtained control of the present Company—Mt. Isa Mines, Ltd. With the preliminary outlay of a mere two million pounds the growth of Mt. Isa proceeds apace. Mt. Isa has the first underground railway in Queensland; it is about three miles long, and electric locomotives haul the trains over it. The side of the hill holds the huge bins and crushers. The ore from the mine in balanced skips is automatically dumped in the crude ore bins and is fed to the gigantic crushers. Then it passes to the screening towers and is carried on belt conveyors from the side of the hill to the main mill set in a conveniently formed and compact plain.

When Mt. Isa was discovered there was no water, though it is needed in millions of gallons to run a mill for many years. Bores were sunk, and a good artesian supply obtained. One of the biggest schemes first undertaken was the reservoir at Rifle Creek, twenty miles away. A huge dam was built between two hills and to-day the completed wall of concrete stands in a desolate, uninhabited stretch of country, a monument to far-seeing engineers. The wings of the wall are sixty feet high, and the spillway is fifty feet above the creek bed. It impounds 1,400,000,000 gallons of water. Twenty miles of 12-inch pipe have been laid from the dam to the mines; the dam and reticulation lines cost £150,000, and several other water conservation ventures have been and are to be undertaken.

A most interesting feature of the Mt. Isa undertaking is the town itself. Realising that a competent and contented staff is essential to the successful exploitation of the mineral wealth of the field, Mt. Isa Mines, Ltd., has provided homes for its workers, amusement halls, a club, swimming baths, parks and other comforts. Single men have been provided for in large roomy well-ventilated buildings, meals are provided in ranches built apart from living communities, and the food is of

the best quality. The land in the town has been subdivided into lots and streets, and for the married men are built neat, airy bungalows with verandas on all four sides, and completely enclosed by fly-proof gauze. War was declared on the fly, the agent of blight and typhoid in the west; all spinifex in the area was burnt out and likely breeding-places cleaned. Altogether it is a model town, and rents would cause envy in the city; family homes are 15/- a week, and rooms for single men 5/- a week.

Mt. Isa is a thirsty spot and the beer bill is the largest in Australia. Some years ago the monthly consumption was nearly 6,000 gallons. All drinks are a shilling each. There is an area of thirty miles north of the town of good rich vegetable land, where vegetables and farm produce are grown. The idea of building a town at Mt. Isa was ridiculed a few years ago, but it has been proved not only possible but an unqualified success. There is a regular train service between Townsville and Mt. Isa, and as the train steams out of this interesting city in the desert, through Dusty Flat, it passes the first houses built of odds and ends of material. They are still occupied, and as it is usually too hot to remain inside the entire family sleeps under the stars.

March of Knowledge.

Elastic Selenium

Two German Scientists, K. H. Meyer and J. F. Sievers, have shown that amorphous selenium, when heated to 70°C, possesses elastic properties. If the threads are rapidly stretched and allowed to contract at ordinary temperatures, they become crystalline, but the substance becomes elastic once more on warming to 72°. Selenium possesses, in the crystalline state, the necessary chain-like arrangement of atoms, which is also characteristic of rubber.

For Television

The demand for photocells of high sensitivity with stable characteristics has led to the development by the General Electric Co. of an Osram Secondary Emission type cell. Secondary Emission cells have sensitivities comparable with or even greater than the gasfilled type of cell hitherto available, and the absence of gasfilling ensures low noise level and a good frequency characteristic with interrupted light. The glass envelope housing the electrode assembly is evacuated and the primary emission from the cathode impinges on another and secondary cathode, which is termed a target, from which secondary electrons are ejected by the impacts of the primary electrons. Each primary electron sets free several secondaries so that a magnification of the primary current is secured. The secondary emission finally reaches a collector which is adjacent to the target and which performs the function of an ordinary anode.

Glass of 2000 B.C.

A Swedish archæological expedition into Egypt, working under Dr. Hjalmar Larsen at the old town of Abu Ghalib, has discovered relics of Egyptian glass manufacture dating from 2000 B.C. The discovery of a mouthpiece of a glass bowl has made it possible to prove that the manufacture of glass in Egypt had begun 500 years earlier than had been hitherto supposed. The mouthpiece is in two layers, with traces of a kernel between the layers, and of a technique similar to the earliest Egyptian glass products. Dr. Larsen supposes it to have belonged to a bowl for cosmetics.

Roman Bath

Excavations by the Worthing Archæological Society on Highdown Hill have now revealed a complete bath system. A party of volunteer workers has cleared the hypocaust,with its apse-shaped annexe, the furnace, an apse-shaped bath, and one of the two pits, each adjoining an apse. The general plan is a basilica-shaped room (above the hypocaust) about 10 ft. by 12 ft., the apse at its eastern end having about a 3 ft. radius. On the south side of this room, from west to east, is the bath-apse, a very small room, and then the stokehole, which is at the east end of the south wall of the hypocaust.

Bug Destruction

Experiments carried out in the laboratory and also in tenement houses have shown that destruction of bed bugs can be effected by spraying affected rooms with coal-tar naphtha at 60° F. or higher and sealing the room for twenty-four hours. This substance is lethal to the insects, is an ovicide, and is not harmful to human beings. This method is claimed as an improvement upon the use of the somewhat dangerous hydrocyanic gas.

Strontium

A work on "Strontium Minerals" recently published by the Imperial Institute, London, discloses the fact that a branch of an industry of some military and commercial significance—that of the production of strontium compounds—has been recently started by a firm in the Birmingham district to displace supplies previously obtained from Germany. This interesting element, first discovered in the lead mines at Strontian, Argyllshire, has developed during recent years uses that were not originally expected. Strontium salts, especially the nitrate and to a lesser extent the carbonate, are used in the manufacture of marine signals, airport and aeroplane landing flares, tracer bullets, parachute signals, military rockets, parade torches, railway flares, and exhibition fireworks.

Book Reviews

The Real Irishman

The Irish Countryman : An Anthropological Study. By CONRAD M. ARENSBERG. (Macmillan. 10s. 6*d*.)

During the last quarter of a century, a re-orientation has taken place in Irish historical learning. Dr. Eoin MacNeill has brought the leadership in Celtic studies home to Ireland from the Continent. His last book, " Early Irish Laws and Institutions," is the first work to describe accurately the political structure of early Ireland, and to show what light is thrown therefrom upon the pre-Roman civilisation of the West. Professor R. A. Stewart Macalister has brought archæological evidence to MacNeill's support. Then, Dr. Robin Flower, of the British Museum, has expounded mediæval Gaelic letters, tracing therein the mind of antiquity, and has described, from the remote Blasket Islands, the " last refuge " of a human type which is " the polar antithesis of the modern civilisation." An aged islander, ten years ago, dictated in Gaelic his autobiography ; he died this year, but his story remains in Irish, and in Flower's translation, to describe " the character of the people about me so that some record of us might live after us, for the like of us will never be again."

This new recognition of Irish history, literature and life as a stream coming down from pre-Imperial Europe has stimulated anthropologists abroad, too ; and Dr. Arensberg of Harvard University has " concentrated on Ireland for the study of European man." Few more understanding books ever have been written by a stranger, than his fascinating volume. He lived among Irish-speaking cottagers in a part of County Clare where as yet the rhythm of the old life is not much hurt by what is called progress. He has depicted those people with a faithfulness which surprises an Irish reader, so long accustomed to less sympathetic work. Political hostility is not the only cause for misunderstanding of olden Ireland. There are folk, both native and foreign, who sentimentalise over the Gaelic life, and whose pictures of a " Celtic " mysticism are just as untrue as the absurd " stage Irishman "—and to Irish people just as irritating. So far from being either wild or mystical, native, historic Ireland is ruled by convention. The people have an age-old ritual of behaviour which stamps with distrust any man who departs from it, and denies to him the opening of their minds. Hence comes the falsity of so many novels and plays, written by men whose personal irregularity has closed to them at the outset the people's confidence. Typically Irish humour, as in country ballads :—

'Twas not the lads of Shercock,
Nor the boys of Ballybay,
But dalin' men from Crossmaglen,
Put whiskey in me tay—

does not signify, as the stage Irish school supposes, that the people think lightly of drunkenness, but rather that they find what is unconventional highly comic. It is the contrast to their native strictness of conduct which causes enjoyment of extravagance. Dr. Arensberg is one of the first foreign writers to discern this truth, though the example which I have given is my own. He etches with scientific patience a picture of the gravity of Irish life, its ceremony, its strength.

Perhaps Dr. Arensberg sometimes builds an overweighty scientific structure on light facts. I published an essay on the cottage parlour, some time ago, describing that shrine of family photographs and religious objects, to which distinguished visitors are admitted, though one so much prefers to get tea in the less stiff surroundings of the big kitchen. This was intended humorously ; but behold Dr. Arensberg going over the same matter and discovering in the sacred parlour a racial symbol ! Then there is the matter of what we unscientifically call clanship, perhaps the most important phenomenon for the anthropologist. Dr. Arensberg draws the Irish family, its ramifications and its rites, in detail. A marriage between an island man and a mainland woman was opposed on the ground that the islanders would not have the benefit of his wife's kin behind him in his need. This Dr. Arensberg finds significant, though, to an Irish mind, it is mere worldly common sense. Yet the scholar is right. Such considerations may be second nature in rural Ireland, but they are not so elsewhere ; and, though these Irish conventions are unwritten, they are none the less formal, persistent, ancient, and characteristic of a world that goes back beyond feudalism and beyond Roman law.

It would be well to read this book after witnessing one of the many plays, or reading one of the numberless novels, which caricature Irish match-making. Though literary sentimentalists deny it, Irishmen know that the system yields happy marriages and secure homes. Here is the man of science to confirm them from his observation, and to demonstrate that the custom is rooted in a wholesome, racial philosophy.

One reservation is suggested. Though Dr. Arensberg, like Irish scholars, finds so much in Ireland, one wonders what results would come from similar enquiry in the antique Scots highlands, in Cymric Wales and Brittany, and in Galicia, the Basque country and Portugal—all regions where something older than the Roman civilisation surely survives ?

HUGH DE BLACAM.

Pre-Cambrian Fossils

Memoir on Fossils of the Late Pre-Cambrian (Newer Proterozoic) from the Adelaide Series of South Australia. Sir T. W. Edgeworth David and R. J. Tillyard. (Angus & Robertson. 7*s.* 6*d.*)

The discovery by the late Sir Edgeworth David of fossil remains of pre-Cambrian age which can be reasonably recognised and described is a scientific event of first-rate importance. Australia is one of the great horsts of the earth, where even Lower Cambrian strata retain in places their original horizontality and the rocks are only slightly compacted, and so offers greater chance of preservation of extremely ancient forms of life than most parts of the world. This book is a description of a relatively rich fauna in the Adelaide Series of South Australia, of an age described as Archæozoic or Proterozoic, stratigraphically far below the Lower Cambrian. The specimens have been reconstructed, described, illustrated and discussed by the late Dr. Tillyard.

Three distinct faunas were met with : at Horizon A the Tea Tree Gully fauna, of giant Annelids and the large Arthropods described in this book : at B, the Beaumont fauna, stratigraphically some 3,500 ft. higher, with the same creatures, and others ; and at C, with a very well preserved but dwarfed fauna. Between B and C there occurred a " stupendous Ice Age," apparently the " greatest ever," represented by the Sturtian Tillite, which the authors propose to correlate with South African, Chinese and North American tillites.

The most important horizon is the oldest, in the Tea Tree quartzites. These are lenticular in form, evidently an old sand-bank, with " abundant algal life," " marvellously rich in giant Annelids and . . . Arthropods."

Here was found " an immense variety of wonderful fossils in profusion," and " the giant Annelids and at least nine other large forms of animal life have been identified." These quartzites are not much more than a metre thick. With the help of a grant from the Royal Society, a quarry face was opened, three yards along the outcrop and twelve feet deep : fifty-five tons of hard quartzite were quarried, and seven tons of selected blocks searched for fossils by being split into thin slabs. The result exceeded the most sanguine expectations.

Out of the " huge mass of material " thus provided, Dr. Tillyard selected four specimens on which to base his somewhat startling conclusions. He finds that they are the remains of Arthropods, remotely resembling the *Eurypterida* but not ancestral to them. The outstanding feature is the primitive nature of the prosoma or head-region, which consists of four segments, distinct and not fused ; also, there is no differentiation of the abdomen into meso- and metasoma, and the appendages are born on extremely distinct segments at the anterior end. On the strength of these features, he erects for their reception a new class of the Arthropoda, which he named *Arthrocephala*, to cover the single genus *Protadelaidea*, with two species, *P. howchini* and *P. browni*.

Dr. Tillyard regarded them as a very early evolutionary expression of the Arachnoid line of development, distinct from the Trilobite-Crustacean stock. In fact, he whets our appetite by the statement, in passing, that recognisable true Crustacea occur in the Tea Tree beds too, but have not yet been described. Further, he considers that the Arthropoda have arisen not from Polychaete ancestors, but from small forms with few segments.

Such results will certainly be received with the customary scientific caution. The authors, anticipating a certain scepticism, have devoted a chapter to the discussion of the evidence. The chief points which they claim in support of the organic nature of the remains are the bilateral symmetry of the specimens, the evidence of segmentation, of segmented appendages, of sculpture, of the duplication of parts, and the co-ordination and balance of parts. Perhaps their general appeal is the most convincing, what Sir Edgeworth David described as " mass-action " upon the judgment of handling thousands of specimens in the field, as compared with the mere examination of a few specimens in a museum. The authors certainly make out a very convincing case.

Malcolm Burr.

The Cave of The Sibyl.

Cumæan Gates : A Reference of the Sixth Æneid to Initiation Pattern. By W. F. Jackson Knight. (Blackwell. 7*s.* 6*d.*)

Mr. Jackson Knight sets out to explain the passage in the Sixth *Æneid*, which describes the cave of the Sibyl at Cumæ and the labyrinth carved in the rock, and thence to trace the history of the labyrinth, originally a tactical design, but later used as a dance figure, and its importance in mortuary beliefs and initiation ritual. The search takes him to China, the island of Malekula, in the New Hebrides, the Grail legend, and the Sumerian epic of Gilgamish : and he finds a number of interesting common factors. One wonders whether our ceremony of beating the bounds of a parish can be connected with the apotropaic circle.

Two types of ritual are distinguished, those in which the dead enter the earth and those in which they cross a river or sea ; these are often combined, and we find myth always attaching itself to fact where there is previously a superficial likeness. The author is very sound here, and, though he barely supports his identification of the labyrinth at Knossos, he does establish the connection between cave, labyrinth and burial belief. He is less good when he makes assertions about the origin of poetry ; and he finds support for a persistent mythic consciousness in Mr. T. S. Eliot's use of ancient symbols, where it would be simpler to suppose that Mr. Eliot, as indeed his notes to *The Waste Land* lead us to believe, found the symbols in ancient writers. As an example of the fields which are ransacked to provide specialists with evidence, the following may be quoted : " One of the most impressive survivals of this (the idea of re-birth in coronation) is the fact that the coronation robes in England can be shown to represent symbolically the condition of a baby at birth."

Finally, is it not time someone abolished the immunity of technical works from the laws of English prose ? What Sir Donald Tovey has done for the literature of music might well be applied to all the arts and sciences. We should at least be saved from sentences like this : " This seems to be a different kind of stone, effective and in a sense divine though it may have been considered to be."

W. B. Dean.

Moulding the Modern World.

The Quaternary Ice Age By W. B. Wright. (Macmillan. 25*s.*)

The shortest and latest of the geological periods is the one that comes home to us most of all, for even if it occupies a mere half-million years or so, it is for humanity all-important, owing to its direct influence upon the soil and scenery, and because it covers the period of our evolution. The Pleistocene Period is of equal significance to the geologist, to the zoologist, to the botanist, to the anthropologist, to the agriculturalist, and to the engineer. It is also extremely complex, and though much studied, offers

still a whole string of unsolved problems. The literature is so extensive and scattered, and largely in foreign publications, that it has been very difficult for the non-specialist to keep abreast of modern thought on all aspects of this absorbing series of subjects. Mr. Wright, therefore, puts us all under a debt of gratitude for this clear and able summary, in which he brings up-to-date his earlier work, which appeared just before the war.

The author has embraced a wide field. He deals with the Pleistocene, not of Great Britain alone, nor only of northern Europe, but also of North America, with which we have so much in common, and of the Alps, classic ground which all geologists should know; he treats, likewise, of that interesting formation, the loess, with which so few Englishmen are familiar. One of the most important chapters gives descriptions of the late oscillations in Fennoscandia, which have been worked out in such detail by Scandinavian geologists. Post-glacial changes in north-west Europe are also summarised. The work is mainly a statement of facts and description of phenomena, and can be regarded as a textbook, though the treatment is somewhat uneven. The author seldom allows himself the luxury of theorising, but does claim, in a special chapter, that the late glacial and post-glacial changes in Scandinavia can be explained without invoking complicated earth movements. Mr. Wright makes out a strong case for the mere unchecked isostatic recovery from the effects of the ice-load, combined with a single oscillation of ground level, and he applies this theory to Great Britain and North America.

The book is well-produced and the illustrations are numerous and clear. Here and there are points that call for comment. Wegener is barely alluded to, and his name does not figure in the index. The dwarf pica, *Lagomys pusillus*, is by no means an exclusively steppe animal, for it occurs throughout the *taiga* or forest region of northern Siberia; nor can the saiga be classed as an arctic animal; nor is it accurate to call steatopygy a negroid feature, for Bushmen and Hottentots are not negroes. It is a pity that there is no allusion to the famous woolly rhinoceroses found in the Polish Carpathians in 1907 and 1929, with the soft parts marvellously preserved in ozokerite. Many will be disappointed that the geologists cannot, apparently, yet give us a clear and precise account of the formation of the Straits of Dover, which has had such momentous influence upon our history. On p. 260 there is an awful example of the distortion of foreign names when they pass through the medium of a third language, for "Wilonji" must be a German monstrosity for Viluy, the tributary of the Lena. As a matter of interest it is worth noting that the peculiar burial habit of the Azilian culture described here of scraping off the flesh from the bones, is practised to this day in Central Asia among the Kazaks, as described by Nazaroff.

MALCOLM BURR.

Voyages of a Modern Viking. By HELMER HANSSEN. (Routledge. 10s. 6*d*.)

No book dealing largely with the doings of Roald Amundsen can be dull, but this book, which has a foreword by "Evans of the Broke", is unusually good. It is written with great simplicity, and gives a good impression of the life on polar expeditions. After making the first North West Passage, the sailors went to Nome to celebrate. "There were more than a hundred people, and there were beautiful ladies and dancing and fun till far into the morning." That is an illuminating side light, and other passages of this kind enable the reader to visualise the men "overwintering," sitting month after month on the ship or in small huts, seemingly quite contented and always amicable. On the North West Passage voyage one of the crew issued a broadcast appeal to the Eskimoes for samples of lice. He was inundated with specimens, and some women who brought lice after the demand was satisfied ate them on the spot with every appearance of relish. The life of the Eskimos is very interestingly sketched, and the account of conditions in the isolated Russian settlements in Siberia makes amusing reading. The photographs, though few, are good.

What Science Stands For. By SIR JOHN BOYD ORR, PROFESSOR A. V. HILL, PROFESSOR J. C. PHILIPS, SIR RICHARD GREGORY, SIR A. DANIEL HALL and PROFESSOR LANCELOT HOGBEN. (George Allen & Unwin, Ltd. 5s.)

The joint contributors to this book are Fellows of the Royal Society. Their individual contributions—on the general theme of the impact of science on the community—attracted public attention at the Blackpool Meeting of the British Association, 1936, and in one case formed a notable broadcast. Sir John Boyd Orr tells us that the advance in the science of nutrition in the last twenty years has revolutionised our ideas on the requirements for an adequate diet, but he has other interesting facts to relate in connection with "Nutritional Science and State Planning." Professor A. V. Hill's contribution deals with "The Humanity of Science," and implies that science is a product of human society, *i.e.*, that the progress of science depends upon all those ideas and facilities which are current at any moment in society. Research, whether fundamental or directed, is by no means the only outlet for the chemist's knowledge and craftsmanship, states Professor J. C. Philip in considering "The Chemist and the Community"; "the employment for other than beneficial ends of the substances discovered by the chemist is due, not to his especial wickedness, but to the weakness and backwardness of the human spirit." According to Sir Richard Gregory, the advance of science during the past three or four centuries has had supreme social value in the alleviation of human suffering; progress in physics and chemistry, however, has profoundly altered those social conditions which it is the purpose of social science to study. In his particular contribution on "Cultural and Social Values," he points out that science has created a completely new environment for modern life, but no systematic effort has been made to adapt the social structure to it. Discussing "Knowledge and Power," Sir A. Daniel Hall shows that the greatest of all dangers to civilisation is the temptation that is now being placed in the hands of the power-mongers, and that a technique has been devised not merely to control men by force but to subdue their minds until they desire to be slaves and mere instruments of the Government. The final contribution by Professor Lancelot Hogben, on "Naturalistic Studies in the Education of the Citizen," ends appropriately with the dictum that the place of science in the education of the citizen is to enlist him in the constructive task of using new powers and inventions wisely.

The Petrology of the Igneous Rocks. By the late F. H. HATCH and A. K. WELLS. Ninth Edition. (Allen & Unwin. 15s.)

The first edition of this book was published in 1891, since when the number of pages has been increased three-fold. As a text book it covers a very wide field. The component minerals of the igneous rocks are described in the detail which is needed by students of this branch of geology; the rocks themselves are classified in a manner which makes it possible to simplify their nomenclature. The professional petrologist is, therefore, well

served. Petrology, as a science, however, does not stimulate any exceptional interest in the individual; this is especially noticed by comparison with palæontology. It has a super touch of being "as dry as dust"; it is just so many facts which appear at their worst degree of "dryness" when seen in print. To make it a popular subject might be a difficult task; in addition, the facts might also lose their usefulness. That petrology has a usefulness is quite evident by merely looking at the pages of this book, but a little more might have been said in this connection. The first three chapters treat of the origin, mode of occurrence, and external structure of igneous rocks; they are preceeded by a short introduction of one page, which mainly tells us that "petrology is that department of geological science which has for its object the investigation of the characters, relations and origin of rocks," and that "a rock may be defined as a mineral aggregate possessing more or less geological character." We cannot say there is no truth in such statements, but we do feel that some great truth about studying the rocks in the crust of the earth is being kept from us when we ask, "Of what use is petrology as a study?" and fail to find one chapter wholly devoted to answering that question.

Logical Syntax of Language. By RUDOLF CARNAP. (Kegan Paul. 25*s*.)

It is difficult to express an opinion on this book. Its author has clearly given much attention to certain fundamental problems in logistics. He seeks to develop a logical syntactical language that can be used in symbolic logic (logistics) so as to save that subject from destruction due to the inherent ambiguity of natural language. The major criticism is that it would appear to make formal logic impregnable by making its form logical. From which it follows that the given, and nothing else, is demonstrated. Countess von Zeppelin's translation is admirable, but owing to the fact that the new language is composed of symbols all derived from the German (*e.g.*, glg = equation [from Gleichung]) a first reading is difficult. The language is so constructed as to be impossible to speak and difficult to write. The omission of a comma completely alters the language design. This book has called for very careful printing.

The Archæology of Sussex. By E. CECIL CURWEN. (Methuen. 12*s*. 6*d*.)

Prehistoric archæology provides a method of reconstructing history in the absence of contemporary records, and is an increasingly popular study in Sussex. That is very evident in the chapters of this book, which is one of a series of "County Archæologies," published under the general editorship of Mr. T. D. Kendrick, assistant keeper of British and Medieval Antiquities at the British Museum. Sussex, indeed, is so exceptional in prehistoric archæology that even a departure from the plan of the companion volumes has been permissible, mainly in making a special appeal to the general reader, who will be interested in Sussex, not as a county, but as a stretch of England where discoveries of prehistoric concern are especially numerous. At the same time, however, the particular local needs of the Sussex archæologist, in a specialist sense, have not been neglected. This inclusion of a general archæological background is to be commended, for it makes the local antiquities intelligible to those who have no special acquaintance with them.

The opening chapter outlines the methods by which the results of excavations are used to reconstruct the story of the developments which have taken place in the life of the people. In subsequent chapters we read about primæval hunters and food gatherers, and of the stone implements which they have left behind, of the methods by which these implements were made, and of the mining of the flint; of the coming of bronze, and ultimately of iron; the increasing importance of agriculture, aided by the plough; the development of pottery; and, finally, there is a short chapter on Roman Sussex. Illustrations of antiquities and maps of prehistoric sites are numerous and well chosen. There are also several photographs of sites taken from the air, which have been included to show the value of air-photography in revealing details not previously noticed and in co-ordinating or disentangling the features seen at ground level.

The Sacred Bee in Ancient Times and Folklore. By HILDA M. RANSOME. (Allen & Unwin. 12*s*. 6*d*.)

This book is both a history and an anthology of bee superstition; and it suffers from this dualism. The author's style is anecdotal; she gives many amusing and hitherto inaccessible stories from every age and country: but the indiscriminate collection of references to bees and honey (throughout 300 large pages of small print) makes neither history nor a readable book, and though many will dig here for quotations and references, one may safely predict that few, even the most enthusiastic bee-keepers, will take up the book for pleasure. There are few things so cloying as a surfeit of good stories. Little attempt is made to trace the growth and possible diffusion of customs: they are noted in their different localities, and that is enough. The ancient importance of bees as the sole producers not only of sweetening matter, but also of wax; the sacred character which was bound to be attributed to any creature or substance essential to human life; the identification of the drink of the gods with honey-mead, which was man's sole intoxicant (he would, naturally, put down its alarming effects to divine powers); the variety of superstitions and folk-tales, both ancient and modern, pagan and Christian, attached to the bee from one or other of these causes: this is the theme of a book which, cutting no new ground in archæology or zoology, would have been far more effective if reduced to one-third of its length. It is very well produced and illustrated, and it is a pity there are so many misprints in the early chapters.

Volumetric Analysis. By A. J. MEE. (Heinemann. 7*s*. 6*d*.)

This book makes no pretence of having been written for the professional analytical chemist, but many who are engaged in the practice of chemistry may profit by reading it. Actually, the aim of the author has been centred in preparing the student who needs a knowledge of volumetric analysis to satisfy Higher School Certificate, Open Scholarships and other examining bodies. With this aim particular care has been exercised to make all the instructions of analytical procedure as straightforward as possible and quite free from ambiguity; in other words, to allow the student to proceed with a given experiment without any further help from the science master. Great stress is also laid on the accuracy of volumetric analysis. The majority of the methods, nevertheless, are claimed to be such as will give accurate results in the hands of those with comparatively little experience in chemical analysis. The most useful part of the book from the point of view of the professional analyst comprises Chapter X, which gives over 200 problems in volumetric analysis and hints for their solution.

An Introduction to Freemasonry. By D. KNOOP, M.A., and G. P. JONES, M.A. (Manchester University Press. 3*s.* 6*d.*)

It is not often that we receive a book on freemasonry which is available to the general public, but this text has little to do with the modern idea of the fraternity. It is concerned with possible origins in the time of the middle ages and deals in detail with the activities of builders of all kinds during the last thousand years, and shows how the modern craft has arisen from the original lodges of workmen who were gathered together at the construction of the more important edifices, the most enduring of which, in the form of cathedrals and castles, remain to-day. The text is in two parts, the first mainly devoted to the meaning of the word freemason and the second to a discussion of the relation between the operative masonry of old and the speculative masonry of to-day. Appendices give as complete account as possible of a number of prominent masons in the middle ages and a wealth of documentation and reference to the original sources from which the deductions are made.

The World in Maps. By W. W. JERVIS. (Philip. 7*s.* 6*d.*)

This fascinating and timely book invites many columns of comment and review; in the limited space at our disposal it must suffice to say that it should be in the hands of every traveller, from the professional explorer to the modest hiker, and, emphatically, it should be on the shelves of every teacher of geography. Human geography, to which maps are the cardinal index and illustration, is becoming a more important and more essentially civilising science every day, and here Professor Jervis has presented us with the perfect means of appreciating those very maps at their full value.

The work is, naturally, mainly historical, and very fascinating is the history it contains; but the portion descriptive of modern atlases and topographical maps is no less interesting and important. Professor Jervis is anything but a dryasdust compiler; he has space for picturesque references to the jewel-map of France and the embroidered map of Middlesex made for King Edward VIII; while his bibliography is a model of scholarly completeness. More maps and yet more maps, is the author's demand, as it was that of his famous namesake in the War Office; and more map-reading, too, we must add. Unhappily the wartime stories of officers' inability to read maps, to which Professor Jervis refers, were perfectly true. One who took map-reading classes at the time can confirm them.

Picturing Miracles of Plant and Animal Life. By ARTHUR C. PILLSBURY. (Lippincott. 12*s.* 6*d.*)

It is unfortunate that so many American books should be rendered difficult to read by bad punctuation. Mr. Pillsbury has collected a great deal of sound information, and many extremely good photographs, and has produced a book that grates upon the sensibilities on every page. Explaining the operation of a time-lapse X-ray camera, he writes: "I was using a four-inch roll so made 3 x 4 shadow-graphs, then the light came on, lasted 2′ 20″, went off, the film pulled forward 3″, winding up in the upper magazine." This is scarcely the sort of writing to employ when teaching the elementary points of time-lapse photography, which apparently is the purpose of this book. The photographs are of real interest, but the information in the text is often obscured by unnecessary intrusion of the personal element. However, it undoubtedly contains some material of use to experimenters in time-lapse photography and nature photography in general.

Electrical Inventions (A. M. Low; Nelson, 2*s* 6*d.*) is a book which must have given the author much pleasure to write, apart from the necessity of keeping it within the modest compass of Nelson's "Discovery Books." Professor Low is fully aware of the romance of science, and he rightly regards the discovery of electricity as the most romantic discovery in the world. His style is excellent for such a volume as this, for he has the gift of using elementary language in such a way as to bring out the main features of his subject, and to make the young enthusiast eager for more detail.

A Scientific and Technical Book List.

At the request of the British Council, The Association of Special Libraries and Information Bureaux has undertaken the compilation of a short list of standard scientific and technical books by British authors. The list has been compiled in order to assist the British Council in their efforts to make British scientific and technical books better known abroad, and will be distributed to the librarians of technical training institutions and specialist associations abroad. The list does not pretend to be a complete bibliography. Agriculture and medicine are intentionally omitted. Further, it was stipulated that the list should not greatly exceed three hundred items, that the books should be those still in print and that the authors should be British. Bearing these considerations in mind, it was decided to omit, in general, those classic works which are already known internationally, but to include some of the more "popular" works which are a characteristic British contribution to Science. The limitation of the extent of the list made choice very difficult but the method of compilation was the same in principle as that adopted for the "Aslib" Book-List, *i.e.*, the collated recommendations of forty specialists each advising his own particular section.

The "Select List" should form a valuable check list for any librarian wishing to form a collection of books covering modern science and technology, although, from the nature of it, the list cannot be of such direct value to the specialist in his own field. It is obtainable by "Aslib" members and Library Association members at 1/- per copy, by non-member Book-List subscribers at 2/- per copy and by others at 2/6 per copy.

Books Received.

An Introduction to Modern Thermodynamical Principles. By A. R. UBBELOHDE. (Oxford University Press. 8*s.* 6*d.*)
Weather Rambles. By W. J. HUMPHREYS. (Baillière, Tindall & Cox. 11*s.* 6*d.*)
The Balkans by Bicycle. By W. PAPEL HAMSHER. (Witherby. 8*s.* 6*d.*)
When Temperaments Clash. By MUNRO MACKENZIE. (Murphy. 7*s.* 6*d.*)
Synthetic Rubber. By W. J. S. NAUNTON. (Macmillan. 7*s.* 6*d.*)
Hindu Customs and Their Origins. By STANLEY RICE. (Allen & Unwin. 7*s.* 6*d.*)
Patents for Inventions. By REGINALD HADDEN. (Pitman. 3*s.* 6*d.*)
The Unveiling of Arabia. By R. H. KIERNAN. (Harrap. 12*s.* 6*d.*)
The Khàriàs. By S. C. and R. C. ROY, two volumes ("Man in India" Office, Ranchi. R.11.).
Elementary Genetics. By HANS GRÜNEBERG. (Livingstone, Edinburgh. 1*s.* 6*d.*)
Nematodes Parasitic in Animals. By G. LAPAGE. (Metheun, 3*s.* 6*d.*
A Bird Lover's Britain. By G. K. YEATS. (Philip Allen, 15*s.*)
The Origin and Properties of The Human Aura. By OSCAR BOGNALL. (Kegan Paul, 7*s.* 6*d.*)

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